KONINKLIJKE AKADEMIE VAN WETENSCHAPPEN (I.C.O.-COMMISSIE)

# SCIENCE IN THE NETHERLANDS EAST INDIES

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# SCIENCE IN THE NETHERLANDS EAST INDIES

KONINKLIJKE AKADEMIE VAN WETENSCHAPPEN — AMSTERDAM
("I. C. O."-COMMITTEE).

# SCIENCE IN THE NETHERLANDS EAST INDIES

BY

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EDITED BY

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*Secretary of the "I.C.O."-committee.*

THIS BOOK HAS BEEN PREPARED AND PUBLISHED FOR THE CONVENIENCE OF THE VISITORS OF THE FOURTH PACIFIC SCIENCE CONGRESS.

THE ORIGINAL OF THE PICTURE ON THE COVER OF THIS BOOK IS A WOODCUT BY Mr. TEN KLOOSTER.

THE FINANCIAL SUPPORT OF THE FOLLOWING SCIENTIFIC INSTITUTIONS IN THE NETHERLANDS HAS RENDERED THIS PUBLICATION POSSIBLE:

Koninklijke Akademie van Wetenschappen, afd. Natuurkunde . . . . Amsterdam
Koninklijk Nederlandsch Aardrijkskundig Genootschap . . . . . Amsterdam
Maatschappij tot bevordering van het Natuurkundig Onderzoek der Nederlandsche Koloniën . . . . . Amsterdam
Hollandsche Maatschappij van Wetenschappen . . . . . Haarlem
Kon. Instituut voor Taal-, Land- en Volkenkunde in Ned.-Indië . . The Hague
Genootschap voor Natuur-, Genees- en Heelkunde . . . . . Amsterdam
Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen Utrecht
Nederlandsch Natuur- en Geneeskundig Congres . . . . . Amsterdam

PRINTED BY DE BUSSY - AMSTERDAM

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# PREFACE.

The Executive Committee of the Fourth Pacific Science Congress resolved in one of its first meetings to offer the visitors of the congress a book on "Science in the Netherlands East Indies", whilst the "I.C.O.-committee" in the Netherlands was invited to compile the work.

The members of our committee have gladly complied with this request. In the first place because they had published a number of pamphlets on "The history and present state of Scientific Research in the Dutch East Indies" for the congresses held in Australia and Japan and it was natural that this time again our committee should publish a general scientific survey of the Dutch East Indies; in the second place, because the request of the Executive Committee proved the strength of the ties that bind the Indies and the mother country scientifically.

It appeared at a meeting of the committee held in the autumn of 1927 that everybody was fully prepared to render the publication of this volume possible. At the same time stress was laid on the fact that it was desirable that this book should have a less historical character than the pamphlets published before. At former congresses it was of importance to the East Indies that the visitors should be informed of the development of scientific research in the Indies and what are the organs of this research at present. The aim of the new publication, however, was quite different. It had to give the visitors of the congress a scientific survey of the Netherlands East Indies and inform them at the same time of the results of scientific research in the Archipelago.

It need hardly be said that it is a difficult task for every branch of science to give a regional survey which is at the same time a summary of what has been accomplished in the Indies, but that this difficulty is not equal for all sciences. The result of this is a certain lack of uniformity in the various chapters of this book. It is evident, that a survey of the climate, geology and volcanoes of the Dutch East Indies will also give a survey of what Climatology, Geology and Volcanology have discovered in the course of years; it goes without saying, that for these branches of science there is a congruence between a regional survey and a survey of the scientific results. This congruence does not exist for other branches of science of a less pronounced regional character, such as General Botany; others again such as Physics and Mathematics are so entirely lacking a regional character that they will not be found mentioned in the present volume. For the rest it is obvious that very little has been done in the Indies in the field of pure Physics and Mathematics. It would be very well possible to give a regional survey which is at the same time a survey of the researchwork done for other branches of science, such as Special Botany and Zoology, but

with these the difficulty is that there is such an enormous quantity of material whilst in many respects still so much has to be done to establish order in this material that it is wellnigh impossible to give for these sciences a concise regional survey.

The pamphlets on the history and present state of scientific research in the Dutch East Indies published hitherto by our committee were only about those branches of science that are represented at Pacific Science Congresses. When the present volume was being compiled it soon appeared to be desirable that it should contain articles on other branches of science, especially the humanities, whilst it was also resolved to insert a chapter on veterinary sciences which are not represented at these congresses. It is to be expected that the scholars visiting Java this year will be desirous to learn without too much trouble something about the history of the Archipelago, archaeology, philology etc. We are very pleased to say that a number of scholars have been found ready to write chapters on branches of science which are not represented in the "I. C. O.-committee".

In this way the book has become a compilation of articles written by Dutch scholars who at one time studied different scientific problems concerning the Netherlands East Indies or who are still doing so now. The only chapter that could not be written in Holland is that on scientific institutions in the Indies; we wish to thank Dr. H. J. LAM the first secretary of the congress that he has been found prepared to write this chapter in spite of the fact that he has hardly any spare time. For some other chapters, too, data have been supplied by colleagues of the authors, residing in the Indies and the assistance received from Professor SCHEPERS of Bandung was so important, that his name will be found mentioned among the authors of this book.

The original intention was that this book should be published at the expense of the congress. It was the desire of the board of our committee, however, that it should be not only a kind of present offered to the congress by Dutch scientists but also that it should be published at the expense of scientific institutions in the mother country. In this respect the hopes of the committee have been realized: a great number of scientific institutions, whose names are mentioned on the title page were found ready to support the publication financially and by doing so showed their keen interest in the Indies.

We are glad, that Mr. TEN KLOOSTER the well known artist has had the kindness to allow us to adorn the cover of this book with one of his beautiful woodcuts, representing a landscape in the tropics.

In conclusion we hope that this book may answer its double purpose: in the first place that it may give the visitors of the Fourth Pacific Science Congress a survey of the Dutch East Indies and allow them to form an idea on the progress of science in these overseas dominions, in the second place that it may convince them of the close scientific relations existing between the Indies and the mother country and make them realize that whatever happens in the Indies is watched with eager interest in Holland.

L. RUTTEN.

# GEOGRAPHICAL ASPECT OF THE NETHERLANDS EAST INDIES

by L. VAN VUUREN,
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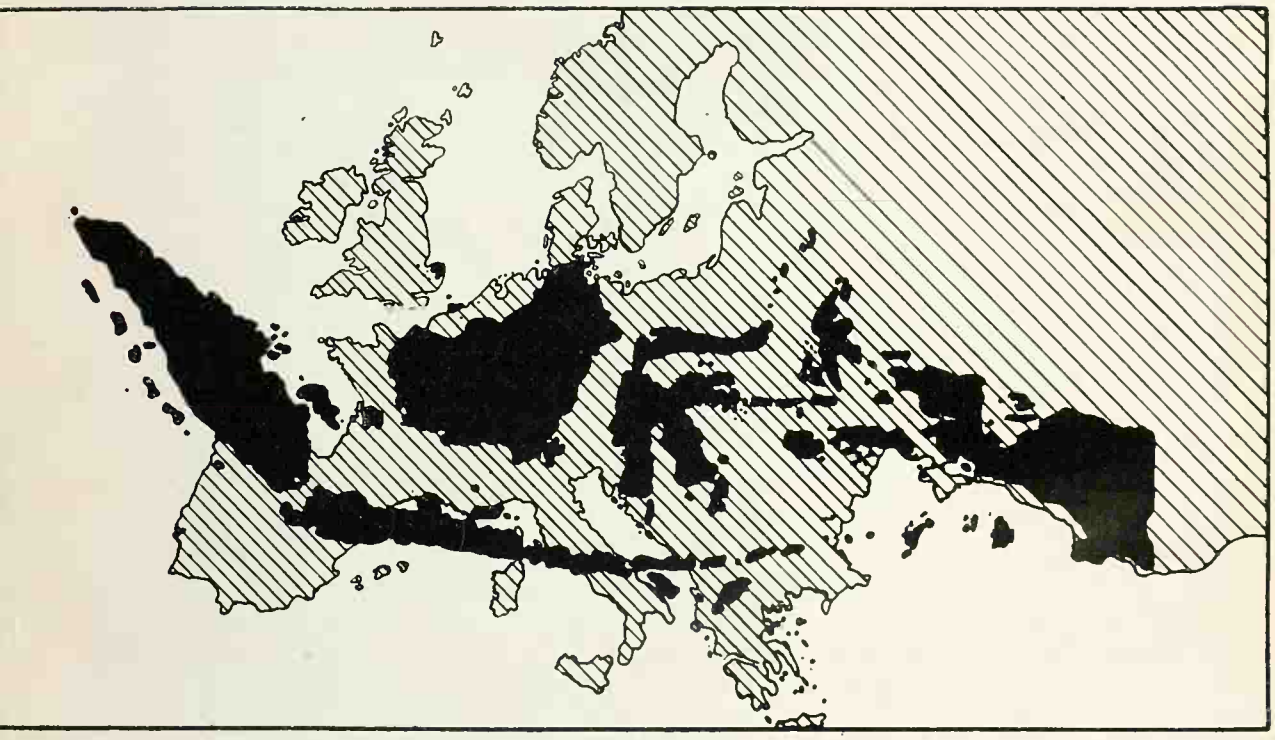


Comparative Areas of East Indies and Europe.

**World Position from a social point of view.** If we glance at a map of South Eastern Asia which includes Japan and India Proper, the Malay Archipelago and Australia with New Guinea, we gain some conception of the inter-relation in the anthropo-geographical sense of this region. India with Ceylon on the one side, Japan with the Liu-Kiu and the Philippines on the other side converge on Borneo and Sumatra, while the main land of Further India with the Malacca Peninsula projects between them with a downward thrust. The Australian Continent pushes the Cape-York-Peninsula in a northerly direction almost up to the

south-coast of New-Guinea, which island with the well-known, "Bird's Head" joins up with the Philippines (via Halmaheira, the Sula's, Celebes and the Sangi- and Talaud isles), while the Banda- and Sunda Archipelagos sweep round in the direction of Java, Borneo and Sumatra.

This connection becomes even more striking, when we consider the great lines of the physical structure of this part of the terrestrial crust. From "The World's Roof" (Pamir) the Himalaya and Kuen-Luen systems — though divergent and enclosing the Tibet-Highland — point eastward; however (east of Tibet) the two systems make a sharp curve southward. Here are the sources of the river Bramaputra, which (rounding Himalaya) flows towards the Gulf of Bengal. With this river commences the first of the longitudinal valleys, the last of which are those formed by the head-rivers of Ho-ang-ho and Jang-tse-kiang, which changing their course in an easterly direction reach the East-China Sea near Shantung and Shanghai, facing the southern point of Japan (Kiu-siu). Between the Bramaputra and the Jang-tse-kiang Further-India's large rivers flow southward: the Irawadi having its mouth near Rangoon and Cape Negrais; the Salween falling into the Bay of Martaban near Mulmein; the Menam reaching the Gulf of Siam near Bangkok on the other side of the Malay Peninsula; and the Mekong which flows through Tonkin, the Shan-States and Cambodja (the land of the Mon-khmers) into the South-China Sea near Saigun.

Except in the case of the Irawadi and the Menam the great rivers have their sources in the heart of South-East-Asia. They run through the inhospitable Tibetan Highland, and from there disperse fan-like between Calcutta and Shantung. Their valleys run south and east via Malacca and Further India to the Malay Archipelago and via China-Proper tot Korea and Japan.

The above geographical relations have affected the population. Much though the opinions of the ethnologists and anthropologists may differ, in *this* most of them agree: that the Malay races originate from the South-East of the Asiatic Continent.

*In pre- and proto-historical times the Malay Archipelago was a Border-land of the Asiatic Continent and received the migrating tribes which were then blended into the amalgama, which now inhabits that region.*

Concerning the causes of the early migrations our knowledge will increase as the pre-historic researches proceed. Even now there are indications showing the probability of the following limits of the migration area: on one side Madagascar and New Guinea-Australia; on the other up to a line Madagascar-Rangoon-Formosa.

In South-East-Asia two of the oldest centres of civilisation slowly developed: India Proper and China, leading down to the "historical

times" that place written evidence at our disposal; either inscriptions on stone or on copper plates, or Indian and Chinese literature. From this evidence (see the résumé in *Geography* published by the I.C.O.-Committee on the occasion of the 2nd Pan-Pacific Congress) it becomes clear how — at the beginning of our era — the brisk traffic between the centres of civilisation was kept up by means of coastwise trade, for which the Malay Archipelago was the thoroughfare.

This Archipelago, extending between Further India and the isolated Australian Continent, was too extended to be circumnavigated: *it had to be crossed.* Hence the great importance — up to the present — of the narrow Malacca-Straits between the Malay Peninsula, and the Sunda-Straits between Sumatra and Java.

There sprang up centres of commerce possessing every qualification for growing into emporia of the products of these fertile isles, products as highly valued then as they are now: spices and precious metals must have been the strongest inducement for Hindoo-traders to be the first settlers in the Malay Archipelago. The countless little islands proved excellent victualling-stations and spoke of the astounding productivity of the Archipelago. Everywhere along the commercial route (either through the Malacca-Straits to East-Java and further on through Makassar-Straits to the Philippines, or from Malacca-Straits along the coasts of Further India to China) there arose Hindoo-Settlements in the western part of the Archipelago, the vestiges of which are still extant. These commercial relations made their influence felt at a very early date. The western part of the Archipelago — partly owing to the fact that it comprises the largest and most fertile islands — was strongly affected by the civilisation of the colonizers from India-Proper, whereas the eastern part was but slightly influenced. Up to this day the eastern part is the least cultured, with the exception of some territories (Minahassa in North-Celebes, and the Ambon-group of islands) where the cultural level was raised by other influences.

Thus these islands gradually became the ultimate object of Hindoo-navigation which carried the costly spices to their own country, or transmitted them (in the Persian Gulf) to the Persian and Arabian traders, who — in their turn — transported the wares — either by sea (the Red Sea) or by land (via Persia) — to the commercial centres of the Mediterranean (Alexandria and others), while the Italian commercial towns distributed them all over Europe.

During a long period this traffic continued the interchange without the need being felt of eliminating the intermediaries. The principal inducement to establish direct communications was the momentous event of Islam's triumphal march following the clearly defined commercial

routes. After the conquest of Constantinople by the Turks (1453) the Italian traders were cut off from the great emporia in the Eastern Mediterranean; consequently Europe was compelled to find a sea-route to mystic India. The inhabitants of the Iberian Peninsula charged themselves with this task, and — for more than a century — they had the control of European relations with Eastern-Asia.

Meanwhile Islam had gained a firm footing in the Malay Archipelago. Towards the end of the 16th and the beginning of the 17th century, before the consummation of the islamizing process, as a result of the circumstance that State-Power had gradually shifted from the Mediterranean to the Atlantic, the task of the Iberians was taken over by the North-Sea nations whose chief object, again, were *the fragrant spices*. The spiceproducing area lay in the eastern part of the Archipelago, and — *for more than two centuries (from the beginning of this Portuguese-Spanish-English-Dutch period)* — *we find there the economic centre*. Ever since the middle of the 17th century the Dutch had control of almost the whole of the Archipelago and East-Asia (China and Japan) trade.

In an increasingly marked degree the Archipelago now became the terminus of trade. Its importance as an area of production increased steadily. Owing to the decline of the spice-trade the economic centre was gradually shifted to the larger western isles, where pepper, coffee, sugar, tin and a few other products came to be of paramount importance. These islands, moreover, became a débouché for a slowly developing industry. This trade — according to the then prevalent commercial views — was a strict monopoly.

The Napoleonic wars suspended the Dutch monopoly for a short period. In 1816 the Archipelago was gradually restored to the Dutch government, but during the interval RAFFLES had founded Singapore, situated on the great thoroughfare leading to East-Asia, and — with the Malacca Peninsula — this sea-port remained a British settlement.

Not before the 2nd half of the 19th century, when Europe had recovered from the crisis of the troubled times (end 18th and beginning 19th century), did broader views begin to gain ground (in 1872 the "differential rights" were abolished), and the development of the Archipelago — as a débouché and as an area of production — was freed from its trammels. There were many other factors favouring its development. When — ever since 1864 — the opening of the Far East was imperiously demanded by the Western Powers; when Japan — through her own exertions — had effected a development unparalelled in history, the Archipelago besides remaining a goal of trade, *again became a thoroughfare* as it had been of yore, when it connected the two great centres of civilisation: China and India-Proper. In the same way as the

Hindoos had been induced by their trade to settle there, the brisk navigation in the 20th century and the great progress of technical skill (cutting of Suez-Isthmus, development of steamnavigation and enormous progress of industry) caused the Archipelago to grow steadily into importance as an area of production and as a worldmarket, and the rapid rise of the Australian Commonwealth greatly contributed to its importance as a transport-area, at the same time increasing the value of Singapore and Malacca-Straits as a British settlement.

These circumstances brought about an almost marvellous development of the Netherlands Indies in the years 1900—1914. The export-figures in 1904 were only 295 million guilders, in 1913 (the year before the Great War) 684 million. In the same years the import-figures were 207 and 500 million. Though the figures have naturally been abnormal during and shortly after the war, and cannot serve as a test for comparison, we may — by way of curiosity — mention the remarkable fact that in 1919 the export estimated to 2 milliards and over, the import-value rose to 800 million. The (annual) British Trade through Malacca-Straits via Singapore is estimated at £ 900 million, and the value of Craft-and-Cargo sailing daily in the far East for and from the United Kingdom is estimated at £ 150 million (H. DUNLOP, Pacifische Problemen, Haagsch Maandblad, Aug. 1924).

The above figures clearly show the great importance of the Netherlands Indies, both in transport-trade and in their status as a débouché and an area of production. Though the figures for 1919 have not continued, the subjoined data will show that the retrogression after the Great War has not been an alarming one.

**Value of the total Import and Export of the Netherlands East Indies.**

| | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 |
|---|---|---|---|---|---|---|---|
| | f 1000 | f 1000 | f 1000 | f 1000 | f 1000 | f 1000 | f 1000 |
| Import | 1.310.825 | 1.244.409 | 782.782 | 651.631 | 706.466 | 824.119 | 873.842 |
| Export | 2.238.868 | 1.195.909 | 1.148.895 | 1.388.188 | 1.557.308 | 1.793.194 | 1.601.315 |

The remarkable development of this tropical *Agricultural Area* had two important consequences: First of all stands that a large part of the native population abandoned the household-economy based on barter for the modern one based on the gold-exchange with all the risks resulting from it. The natives share in the production for the World-Market, from which — at the outset — we might expect disturbances of the social equilibrium. The effects of the War have not only accentuated

them, but have also prepared a fertile soil for nationalist-communist currents that followed the ancient route described above and invaded the Archipelago.

The second consequence is the growing importance of the Dutch Indies as a thoroughfare, with Singapore and Malacca-Straits for its centre, an importance which becomes manifest in the Four-Power-Treaty (Dec. 13th 1921), whereby Great-Britain pledges herself not to make any fortifications east of the 110th degree: consequently *Singapore* — lying to the west of it — can be made the naval base of the Far East.

The preponderant position of Singapore and Straits-Settlements follows also from the fact that 80 % — if not more — of the Netherlands-India import and export sail via this port and straits. Likewise both the national and foreign lines of navigation — almost without exception — take the route of the Straits. In themselves the said lines symbolize the importance of geographical situation of the Archipelago.

Among the national Steam-Navigation-Companies Nederland-Comp. and Rotterdam-Lloyd stand first. Together they keep up a weekly mail-service to and from the mother-country. As early as 1903 the "Nederland" transferred its route from Padang (Sumatra) to Sabang (North Sumatra) and Singapore, a precedent followed by the Lloyd in 1923. In 1906 the two Companies founded the Java-Bengal Line (a monthly carrying-trade line to Rangoon and Calcutta), based on the transport of sugar to India (voyage out) and the import of rice (home voyage). In the same year the Java-Australia Line was founded by the Kon. Ned. Paketvaart Mij. (subsidized by the Government at the outset) from Java-ports via Makassar (South Celebes) to Brisbane, Sydney and Melbourne. The K.P.M. — besides taking upon itself the interinsular traffic — has established with her considerable fleet connections with Singapore, Penang and Portuguese Timor, and with Rangoon, Bangkok and Saigon, based on the import of rice; moreover with Swatow (S. E. China, coolie-transport). Subsidized by the Government (in 1902) the Java-China-Japan Line was founded, based on the transport of sugar from the Indies to Japan, and of coal from Japan to Java. In spite of the grim competition of Japan the subsidy has been quite reimbursed, and the Company who started with only three ships, has now a fleet of 14 steamers of a tonnage of 89.000 R.T. gross.

Conjointly with the Ocean Cy — in 1914 — the "Nederland" and the "Lloyd" founded the Java-New York Line for carrying-trade on the eastern coast of the U.S.; route: Java-Madagascar-Durban-Capetown-Paramaribo (Dutch West-Indies)-New-York. The Holland-America Line is interested in it.

Together with the Java-China-Japan Line — in 1915 — the

"Nederland" and the "Lloyd" established a connection with the West-Coast of South America (Valparaiso), using the rail-road to Buenos-Aires as a connection with the mother-country. This Line could not support itself after the war.

During the war — in 1917 — the mail-steamers, then lying in Indian ports, opened the communication Java-San Francisco for the conveyance of travellers arriving at New York (by Holland-America Line) and having proceeded from there to San Francisco. This Line lasted till the Armistice. However in 1915 — together with "Nederland", "Lloyd", and Java-China-Japan Line — a permanent connection had been established between Java-China-Japan and the west-coast of the U.S.: the Java-Pacific Line.

There is also a considerable transport from the Indies to Foreign Countries under foreign flags. There is a regular service Singapore-Java-Australia of the Burns-Philp Line and the West Australian Joint Service, and of late the Commonwealth-Government Line of Steamers have begun to touch at N.E.I. ports. The communication with British India is kept up by the British-India Steam-Navigation Cy, and the Asiatic S.S. Cy. The ships of the Ocean S.S. Cy sail for East-Asia and Europe; also the China-Mutual S.S. Cy (blue funnels under the British flag).

In the course of the war the German trade flag had disappeared, but now the Deutsch Australische Dampfschiff-Gesellschaft has opened a service from Europe to Australia via the Netherlands Indies. The ships of the Nanyo-Yusen-Kaisha, the Osaka-Shosen-Kaisha and the Tokyo-Kisen-Kaisha are plying — via East-Asia — between the Netherlands East Indies and Japan. The Swedish Cy Rederi Aktie bolaget Transatlantic and the Danish Ostasiatiske Kompagni have a share in the navigation N.E.I.-Europe, while the Norwegian Cy Norske Afrika og Australie Linje takes the route indicated by the name. Besides the Dutch Navigation-Cies foreign Cies have a share of the considerable transport of Mecca-Pilgrims from the N.E.I. to Djeddah, there and back.

The Koninklijke Nederlandsche Petroleum My transports its products in its own fleet — under the Dutch and the British flag — to the depots and to foreign countries, which has given rise to a brisk traffic between the N.E.I. areas of production and refinery, Singapore and other foreign ports.

For the purposes of State-Supervision the government has at its disposal the so-called "Gouvernements-Marine", to which also belong the numerous regional vessels, the ships of the State-Monopoly of Opium, and the cable-ship that has to keep the telegraph-cables in repair.

During the shipping period of the cane-sugar made in the N.E.I. (Sept./end of January) many freighters visit the Java sugar-ports.

The statistic given in Appendix I and II is meant to supplement the above succinct exposition of shipping-conditions.

From the above exposition it may become clear that the principal ports of the N.E.I. are lying *within* the curves shown by the islands. Singapore holds a central position on the great road of access through Malacca-Strait. At the entrance to the strait the N.E.I. Government has established the coal-port Sabang on the isle of Pulu-Weh near the northern point of Sumatra. Belawan is the export-harbour of an important area of production: the East-Coast of Sumatra (Deli). This harbour is connected with the Interior by means of the Deli-railway (linked up with the Atjeh-tramway); its harbour-works have been recently modernized, and its fairway-lane has been improved so as to permit the great ocean-steamers to moor alongside of the quays.

The harbour of the second-rate access (Sunda-Straits) is Tandjong-Priok, the port of Batavia, the capital of the N.E.I. situated on the Bay of Batavia (North Coast of Java). Tandjong-Priok is the import- and export-harbour of Western-Java, with which it is connected by an excellent network of railways and motor-roads. The harbour-works and wharfs can cope with the highest demands.

Semarang is the important export-harbour of Central Java and its sugar-estates. It, too, is connected with the "hinterland" by means of railways. The nautical conditions, however, are far less favourable here. The steamers have to anchor in the roads, and the transport of goods is effected by means of loading- and unloading-proas. The communication is seriously impeded during the west-monsoon.

The port of Surabaya, again, is very favourably situated at the mouth of the Brantas (Kali-Surabaya). A well-developed system of railways connects the harbour with the fertile "hinterland", which — first and foremost — is a centre of sugar-growing, and practically includes the whole of Eastern Java, though Pasuruan, Probolingo and Panarukan (all connected with the Interior by railroads) have also a share in the export.

The only harbour of any importance on the South-Coast of Java is Tjilatjap; a side-branch connects it with the railway-system of Central Java.

On the West-Coast of the southern peninsula of Celebes lies Makassar-port, the staple of the products of the East-Archipelago, besides being the distribution-port for the import into those parts. Both at Surabaya and Makassar the wharfs have — of late years — been entirely modernized and adapted to the growing traffic of steamers of high tonnage. Some figures may illustrate the importance of the said ports (see Appendix 2).

**World Position from a physical point of view. Natural features of the area. Population-problem.** When considering East-Asia on a physical map, one is immediately struck by the string of islands surrounding the whole of the East-Coast of the Asiatic continent. Their convex side is turned towards the Pacific, the concave side towards the continent, separated from it by basins of various depths. The aspect of the islands in the great Archipelago between Asia and Australia is far more complicated. We commonly take all the islands together under the name of Malay- (or Austral-Asiatic) Archipelago, most of which belong to the Netherlands East-Indies.

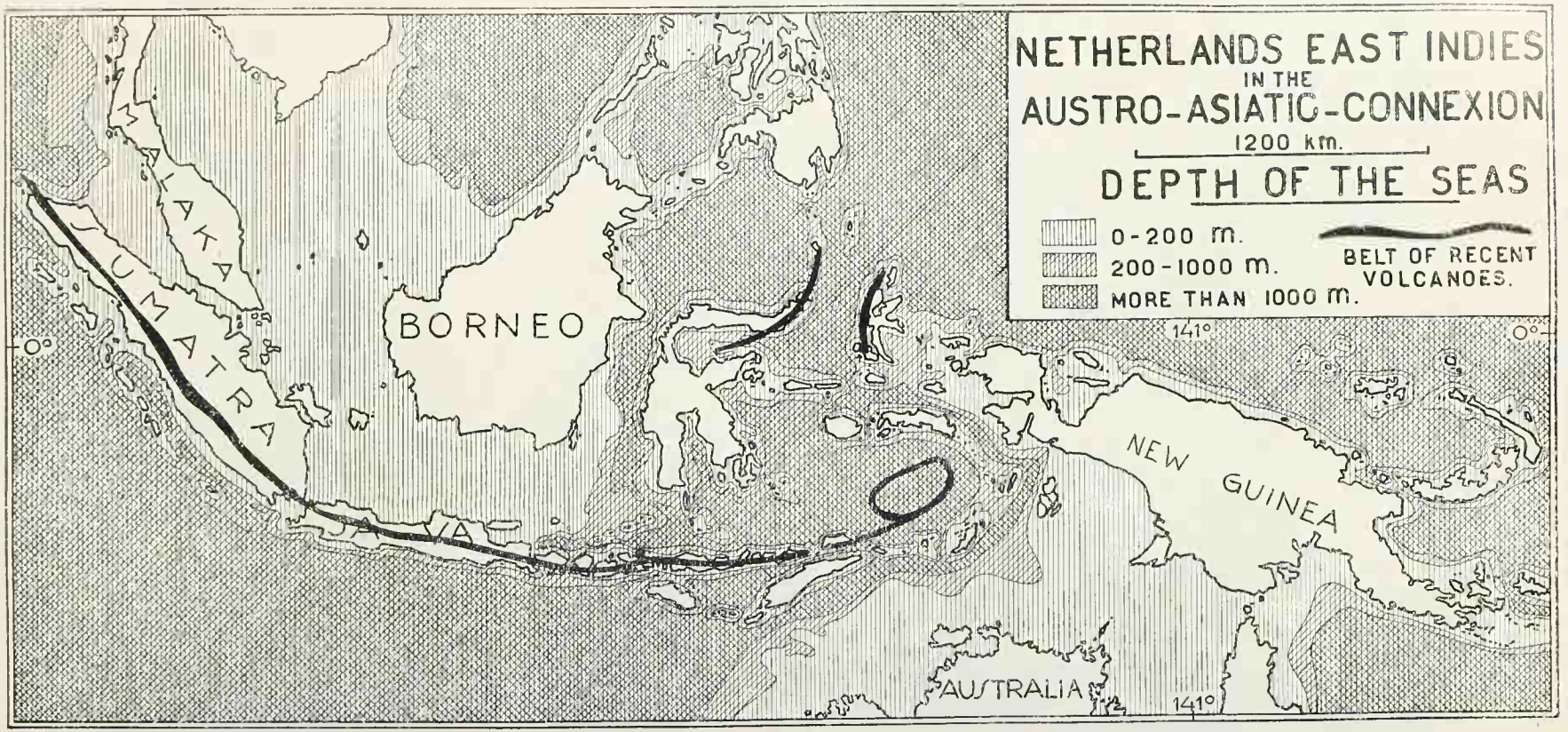
On the southern side the A.A. Archipelago borders upon the Australian continent and the Indian Ocean; on the east-side upon the Pacific; on the west-side upon the Indian Ocean and the Bay of Bengal. The northern border-line might be drawn: North-point of Formosa — Hainan — Cape Negrais — westward of the Irawaddi-mouth — South-Burmah. This line symbolizes more or less the connection between and the continuity of the Asiatic continent and the Archipelago. (See map I.)

If we consider the map of this large group of islands in connection with its surroundings, we become aware of some facts that have strongly influenced the social-economic development of this part of the world.

In the first place: the continuation of the Burmah mountain-ranges along the double arc of islands, surrounding the Archipelago on the west- and south-side. The outer arc appears to be a continuation of the Andaman and Nicobar islands along the islands west of Sumatra: Simalur, Nias, Batu-islands, Mentawei, Pagai-islands, and Engano. South of Java this range is intersected by a "deep sea trough". Near Sumba (south of Flores) the outer-curve reappears and continues by Sawu and Roti over Timor, Kissar, Moa, Babar, the Tenimber islands, the Key and Aru islands, where the arc takes a sharp curve to the North-West and West via Ceram and Buru. This arc is the *non volcanic outer-arc.*

Within it lies the inner arc formed by the large islands of Sumatra and Java. It is continued over the lesser Sunda-islands: Bali, Lombok Sumbawa, Flores, the Solor-islands, the Alor-islands, Wetar, Roma, Damar, Teon, Nila, Serua, where the arc curves towards the N.W. and W. over Manuk and the Banda-group towards the Schildpad and Lucipara-islands. This is the *volcanic inner-arc*, which makes the N.E.I. one of the most important volcanic territories of the Earth. In double-rows the volcanoes are arranged along the great Sumatra longitudinal valley from the North-Point of Atjeh to the Bay of Lampong (near Sunda-Straits, South-Sumatra). They crown the ridges of the western mountains of Sumatra, known by the general name of the Barisan mountain-range. They continue over Java: at first as the continuous mountaineous district

Map 1.


NETHERLANDS EAST INDIES
IN THE
AUSTRO-ASIATIC-CONNEXION
1200 km.
DEPTH OF THE SEAS
0-200 m.
200-1000 m.
MORE THAN 1000 m.
BELT OF RECENT VOLCANOES.
BORNEO
SUMATRA
JAVA
NEW GUINEA
AUSTRALIA
0°
141°

of West-Java, farther on as isolated mountains emerging from the plains of East-Java. The discontinuity becomes more and more conspicuous as we proceed eastward to the insular arcs, the portions of which we have mentioned above. Proceeding eastward the volcanic range continues round the deep basin of the Banda-Sea.

The mountain-chain of New-Guinea with its high snow-clad summits appears to find its continuation in the row of island-groups extending from east to west: Misool, Obi, Sula- and Banggai-islands; at all events this row separates the southern volcanic arcs from the northern ones, embracing the volcanoes of the oddly-shaped Halmaheira and of the islands on its western border; moreover the range that stretches from the Togian islands (Una-Una-) via Minahassa (North-Point of Celebes) to the Sangi isles.

It is this recent volcanism to which Sumatra and Java owe their fertile soil, which — together with the climate — has made Java one of the most densely populated agricultural areas of the World.

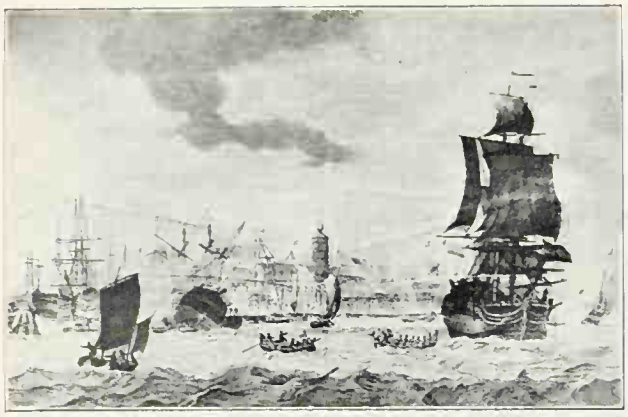
Its astounding fertility especially in the central and eastern parts is a consequence of the nature of the volcanic layers (whose basicity increases as we proceed farther east), and of the climate, which causes the amount of rainfall gradually to become less towards the East, so that — in the eastern areas — we find a natural ameliorating-process of the soil, in contrast with the impoverishing of the soil, owing to strong lixivation, in the western areas.

In two regions the above-mentioned mutual connection becomes evident. Round Lake Toba (see Plate I) (East-Coast of Sumatra) lies a large area of acid liparitic effusiva. On the east-side — in the centre of this acid tufa cap — lies an area of more basic andesitic effusiva. It extends over a lenght of about 70 km between the river Wampu (north) and the Buaja (south). Its breadth (near the coast) is about 40 km. *Now, this area covers exactly the world-famed tobacco-growth area: East-Coast of Sumatra (Deli-Tobacco; Wrapper-Leaf).* (See Map II).

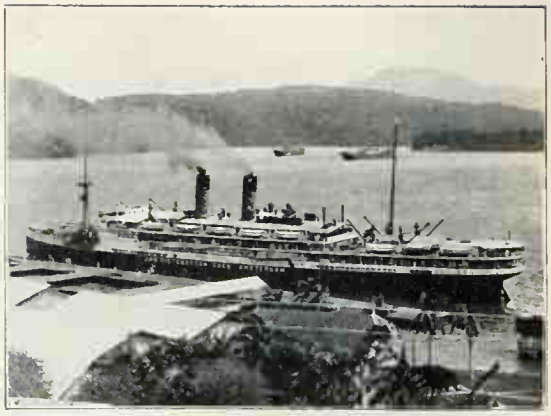
Every attempt to extend tobacco-culture beyond the boundaries of this area (in times when circumstances were favourable) has proved a failure. The nature of the soil, the favourable distribution of the rainfall, and the absence of strong winds have kept the cultivation within the natural boundaries defined above. Round about the tobacco-area — in the lower districts — are grouped the Hevea-plantations; in the higher regions (above 300 m.) the tea-plantations with the centre Pematang Siantar, and still higher the coffee-plantations (Liberia). Of late the oil-palm has been planted on a large scale.

The second region illustrating the relation between fertility and nature of the volcanic material lies in West-Java. In Bantam the soil

Plate I.



Return of one of the first Netherlands East Indian fleets to Amsterdam about 1600.



Modern Mail-steamer.

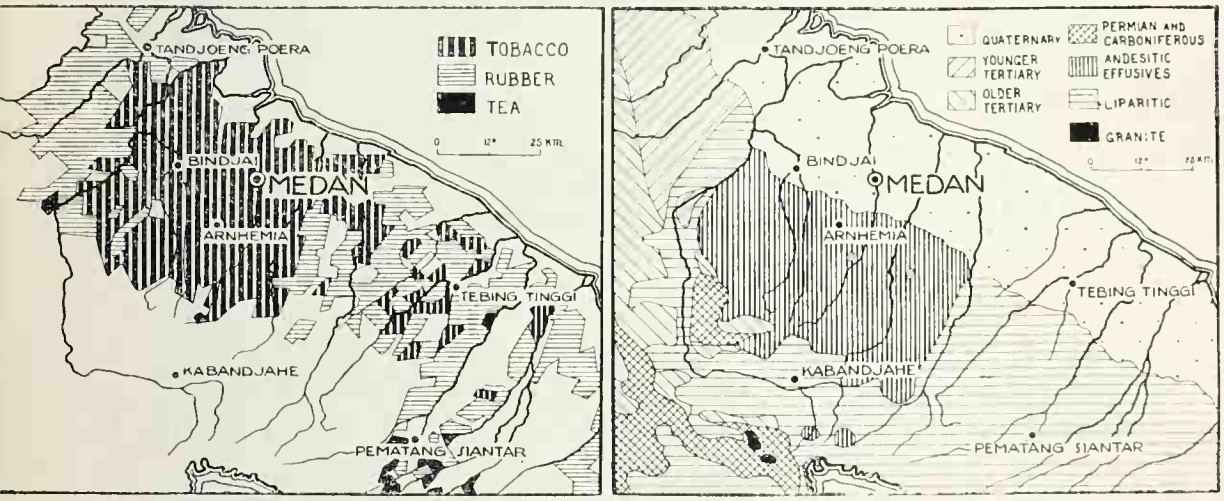
Lake of Toba Panorama from Perapat. (East-coast Sumatra).

Plateau of Bandung with "Bosscha-Observatory" (West-Java).

consists largely of acid pumice-tufa. Hence Bantam is one of the poorest and least populated districts of Java.

Besides its important social-economic function we owe to the volcanic nature the majestic beauty of the landscape in all the islands belonging to the above-named arcs. In the western islands (as far as West-Java) volcanoes crown the mountain-ridges, mostly showing the original purely conical shape. They command the landscape far and wide, and we need not wonder that their high peaks and deep craters have suggested to the natives many legends and sagas that still live on among them. They ring round the magnificent table lands formed by the volcanic eruptions, and the beauty of the landscape is often

Map II.




heightened by large mountain-lakes, reflecting the silhouettes of the volcanoes in their deep-blue waters.

In this regard we must mention Takengön-plateau with Lake Laut Tawar in N. Sumatra. To the south of it we find the splendid Lake Toba (of tectonic origin) surrounded by volcanoes covering with their volcanic materials the land of the Karo- and Toba-Bataks (N. and S. of the lake). Its water-line is at 600 m., its banks reach 600 m. higher. In it there is an island: Samosir. Its area (island included) is no less than 2050 sq. km. (Lake Léman: 582 km².). There is no spot in the world where volcanism shows a more grandiose aspect. W. Volz estimates the area of the tufa-plateaus round the lake at 40.000 sq. km. and over; their depth in the central parts being 500 to 600 m. Further south we find the table-lands of the original country of the Minangkabau-Malays, the beauty of which has been enhanced by the hand of Man, having for

central places: Fort de Kock, Pajakumbo and Solok. Here are the beautiful mountain-lakes: Manindjau (crater-lake; height 459 m. above s.l.; area 100 sq. km. and Singkarak (tectonic, 362 m. above s.l.; area 100 sq. km.). Further southward follows the imposing plateau of Kurintji with the Lake of that name (tectonic; 733 m. ab.s.l.; area 50 sq. km.). Farther on — here we enter S. Sumatra (see Plate III) — lies the fertile table-land of Pasemáh on the upper course of the river Musi, and then the series of beautiful volcanic landscapes is closed by the crater-lake Ranau (559 m. ab. s.l.; area 106 sq. km.). In Sunda-Straits rises Krakatau of world-wide fame since the eruption in 1883; at the present moment again showing eruptive activity. In Java — in the centre of W.J. — we find the Plateau of Bandung (see Plate I). Surrounded by a wreath of splendid volcano-silhouettes this plateau (with the smaller — but not less beautiful — one of Garut) has become an agricultural centre of great fertility and beauty (see Map III). Here already are seen the first traces of greater basicity of the volcanic materials, which produced in the famous "volcanic quadrangle" of Central-Java *the most densely populated agricultural area in the world*. Sindoro, Sumbing, Merbabu (the three of them over 3000 m.) (see Plate II) and Merapi (2911 m.) surround the central landscape of the province Kedu with districts of more than 600 souls per sq. km., the province as a whole numbering over 400 inhabitants per sq. km.

The isolated character of the volcanoes (rising from the plains and thus giving more relief to their imposing outlines) becomes more conspicuous as we proceed farther east. Via Lawu (3296), Willis (2550) and Kelud (1734) the string of volcanoes proceeds to the well-known complex of Tengger (south of Surabaya) with the "Zandzee" on whose northern slopes we find the health-resort *Tosari* offering a splendid view of Ardjuno (3343). In the farthest east the Java-portion of the arc is closed by Idjen-plateau, one of the most remarkable volcanic areas in the world.

The isolated character of the volcanoes is now displayed in the dismembered condition of the lesser Sunda-isles; we mention some of them: glorious Bali with Mount Batur to which the southern half owes its fertility; Rindjani in the isle of Lombok (3800) the two of them with crater-lakes of great beauty; the numerous volcanoes of Flores (see Plate II). among which is conspicuous Mutu in Endeh with three magnificent craterlakes: one dark-red, the second green and the third bright-blue. The landscape is one of thrilling beauty (within easy reach of Endeh, a harbour touched at by the K.P.M. steamers). Further eastward lies the isle of Wetar which shows extinction of recent volcanism. Of the volcanoes round the deep basin of the Banda-sea we mention the Gunung Api of Banda (see Plate II) with its splendid bay.

With regard to the northern arcs suffice it to mention: the well-

Kampong Gedakan on the slope of the Merbabu 6000' above s.l. (Kedu. Central Java).

Gunung Api (Fire Mountain). Banda Neira.

Landscape on the non-volcanic isle of Sumba.

Panorama of the White Lake (Tuwu ata mbupu) (Central Flores).

Plate II.

known Peak of Ternate in the row to the west of Halmaheira; of the other northern row the volcanoes of Minahassa are worth mentioning, since here volcanism has raised the standard of life of the highly civilised Menadonese group of natives.

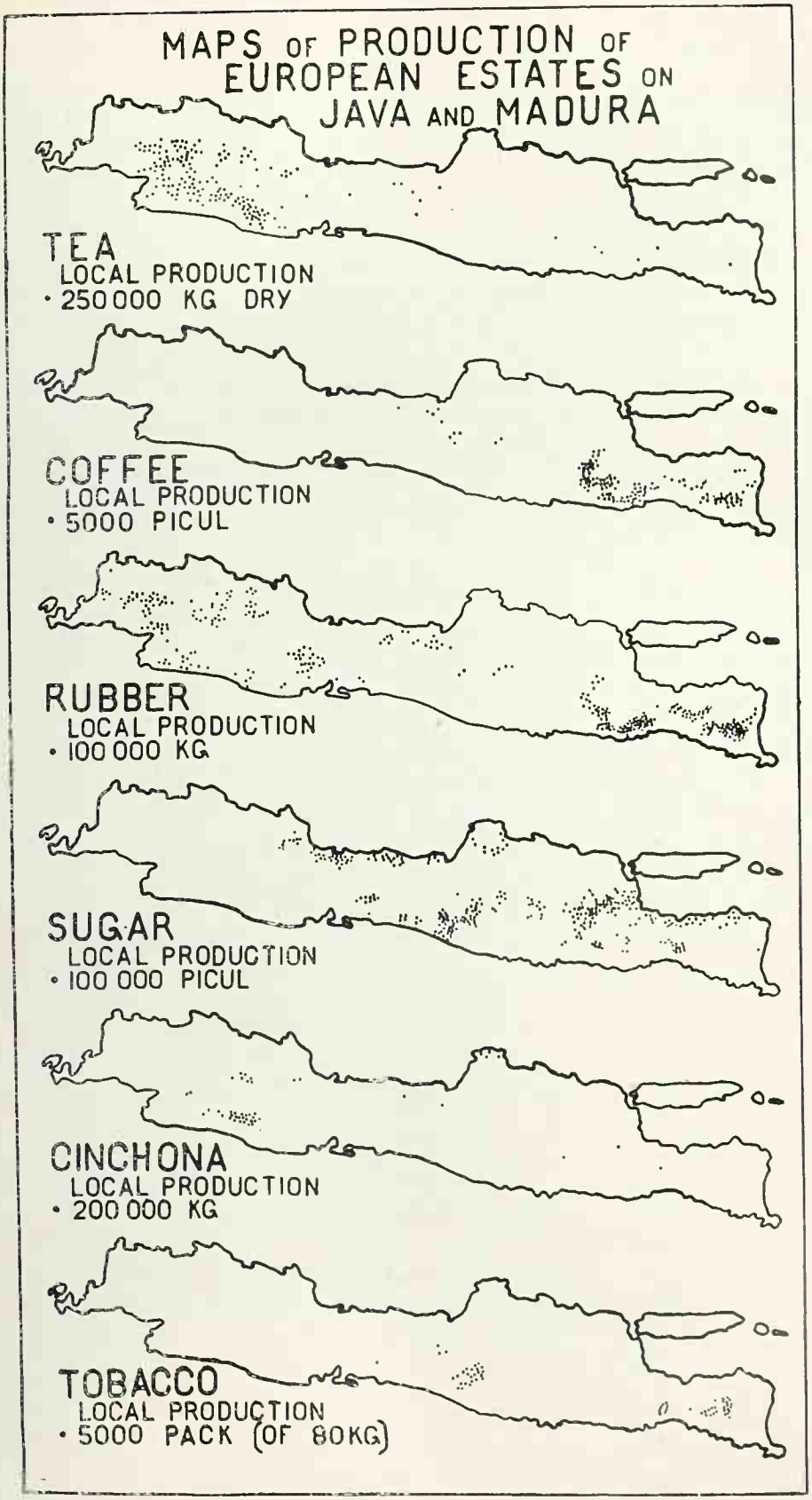
In Central Celebes we find subrecent volcanism in the form of extensive mud-streams on the upper course of the Saädang; the southern peninsula is so to say blocked up by the volcanic cone of Lompo Batang (Big Belly). Hitherto it has been impossible to show a connection between these volcanic mountains and the northern row of Celebes. Though — of late years — traces of subrecent volcanism have been found in Eastern Borneo, we may state the fact that Borneo has lacked the beneficent influence of quaternary volcanism, the reason why it is far behind the other islands as to fertility, development and density of population. The same remark holds good for the extensive island of New Guinea in the far east, likewise for the isles of the Outer Arc: Sumba, Timor, Tanimber, Key- and Aru islands, Ceram and Buru, and the group north of them: Misool, Obi, Sula- and Banggai islands.

From whichever side we enter the Archipelago, everywhere our eye detects volcanoes standing sentry, so to say, and rising high above the landscape. Their bald summits, often provided with crater-lakes, reach up to 3000 m. and higher. At a height of 2000 m. we meet the first traces of cultivated areas; the splendid tropical woods reach down to 1000 m. above the level of the sea. Here we meet already the rice-fields of the native population, and their gardens where other food-stuffs are grown, surrounded by European cinchona (see Plate III), coffee, and tea estates, the latter extending down to 300 m. above sea level. Especially the plateaus above mentioned are entirely taken up by the native rice-fields and gardens, whereas the European estates cover the surrounding volcanic slopes.

Below the 300 m.-limit the tertiary hills pierce in many places through the cover of tufa. Here begins the area of native rubber-plantations and European estates. Here, too, we find the tobacco-plantations of both natives and Europeans, and in the plains — fertilized by the silt which the rivers carry down from the volcanic slopes — in Central- and East-Java cane-sugar and rice predominate.

The alluvial plains along the coasts are marshes and swamps, densely overgrown with rhizophores and Nipa-palms, through which the rivers laboriously wind their way. Behind the swamps we find the first coco-palms growing sparsely between the other plantations. They are most fruitful in the lower regions, but in some places their domain reaches up to 800 m.

A closer consideration of the map will show that in the volcanic


MAPS OF PRODUCTION OF EUROPEAN ESTATES ON JAVA AND MADURA
TEA
LOCAL PRODUCTION
• 250 000 KG DRY
COFFEE
LOCAL PRODUCTION
• 5000 PICUL
RUBBER
LOCAL PRODUCTION
• 100 000 KG
SUGAR
LOCAL PRODUCTION
• 100 000 PICUL
CINCHONA
LOCAL PRODUCTION
• 200 000 KG
TOBACCO
LOCAL PRODUCTION
• 5000 PACK (OF 80KG)

arc — described above — the mountain region is to be found on the western and southern side, i.e. on the *outer side* of the arc. The large plains extend on the *inner side*. Sumatra shows the broadest strip of plains on the east-side, Java on the north-side. The great rivers flow in the same direction: navigable up to far into the interior of Sumatra, of little value for navigation in Java. These conditions define the traffic-possibilities from west to east in Sumatra, from north to south in Java. The main commercial inland roads run longitudinally. However — in Sumatra — one can conveniently cross the island from West to East by motor-car, and enjoy the majestic beauty of the western montains. From Padang the West-Sumatra railway takes you to the splendid plateau of Fort de Kock and Pajakumbo; from there you go by motor-car through the heart of the Barisan-mountains via Lubuk Sikaping-Penjabungan — Padang Sidempuan and Tarutung to Balige on the magnificent Lake Toba. Here you may take a motor-boat and — crossing the lake — reach Tiga Ras, where the car is waiting for you to descend — through the tea-plantations of Pamatang Siantar, along the coffee-plantations and rubber-gardens and — lower still — through the unequalled tobacco-fields of the East-Coast of Sumatra. This fine and instructive excursion gives us in every respect a faithful idea of the agriculture and vegetation of the island, and also of native and european agriculture.

A second excursion across the island takes us over the southern part of the Barisan, starting at Benkulen on the west-coast. As the strip of lowland along the coast is very narrow here, we soon reach the western mountain slopes. Via Kepajang we can round the massive bulk of Kabah-volcano on either side. By the northern way we reach Muara Bliti on an affluent of the Musi; by the southern road we can cross the great longitudinal valley via Pagar Alam towards Lahat, where we find communication with the South-Sumatra railway to Palembang. This trip likewise gives us a fair idea of the structure of the island, and makes us acquainted with one of the principal river-basins of the eastern plain: Musi with its coal- and oil-fields (Musi-basin 61.200 sq. km. Holland 33.000 sq. km.).

The best way to get acquainted with West-Java is a trip from Batavia (by rail or motor-car across the northern plain) to the Governor-General's residency: Buitenzorg, situated at the foot of the western mountains.

In the coastal plains we find the rice-fields surrounding the dessas (villages) mostly lying amidst coco-plantations. Further on extend the rubber-plantations of the Europeans; southward we see the volcanoes Salak and Gedeh; the motor- and the railroad are between. On the

slopes we find in the same order as before: rice-fields, native and European tea-gardens, above them the coffee-gardens, and finally the virgin forests, above which arise the summits of Salak and Gedeh. Round the southern foot of the Gedeh — laboriously winding upward — the road climbs towards the border of the plateau of Bandung (Padalarang). Here we survey the entire table-land with its imposing mountain-frame. Volcanoes crown the high borders, and the slopes — up to the 1000 m. limit — are covered with rice-fields and plantations of the natives (the Sundanese). We are struck with the prosperity of the whole region, and the traveller will soon rid himself of the notion — stamped upon his mind by literature — that „Orientals are lazy": the plantations up to the lofty borders of the volcano-slopes will undeceive him. We proceed across the plateau via Bandung which holds a central position, to the eastern border, where Tjitjalenka puts a stop to the level road. Here the road climbs over the border winding through mighty volcano-complexes towards Tjibatu, whence a branch-line leads to the no less prosperous and beautiful plateau of Garut. A magnificent motor-car road leads past the elegant cone of the Tjikurai, the Guntur and the Papandajan, past rice-fields, tea-, coffee-, and cinchona-estates, via Tjikadjang across the southern mountain-range towards the steep south-coast, where we arrive at Pameungpeuk on the fine bay of Tji-Laut-Eureun, where the Indian Ocean is reached. So far for West-Java. (See Map III).

The best way to form a conception of Central-Java is to make a trip from Semarang, the well-known northern harbour, across the narrow coastal plain to the "saddle" between Merbabu and Ungaran, followed by the descent into the valley enclosed by the above-mentioned quadrangle of volcanoes, covering the province of Kedu with Magelang in its centre. Here the native population and their rice-culture predominate. The road continues southward via Muntilan (with the monuments of ancient Hindoo culture: Buru-Budur, Mendut etc.) to the plain of Djokjakarta.

On the higher fields tobacco is grown; on the lower ones: sugar and rice. The great sugar-estates are grouped around on either side of the railway Djokjakarta-Surakarta, a section of the axis-line Batavia-Surabaya and further east. From Djokjakarta we can reach (by auto) Wonosari, giving a fair sample of the tropical karst-landscape of the Gunung Sèwö or the thousand-mountains. Its contrast with the prosperous volcanic domain we have just left, is striking. Wherever the sparse detritus of the calcareous soil washed down into depressions, the natives have laid out scrubby gardens for food-provision, surrounded by lime-stone walls. The aspect of this landscape shows clearly the social-economic function of volcanism!

This contrast also impresses us when we travel — by tramcar — from Semarang across the tertiary hills of the northern province Rembang to Surabaya. Here is the domain of the djati-woods (Government-culture) with Blora for its centre; here, too, is the centre of Java Oil-Industry (Tjepu).

Again we see the picture of prosperity and intensive culture when travelling — by rail or auto — from Surabaya through the fertile delta and plains of the Brantas, their fertility being mainly due to the volcanic products carried along by that river, periodic activity of the Kelud supplying a constant renewal. It is here that we find the ricefields with the highest yield per unit-area, and all along the road Surabaya-Modjokerto-Djombang-Kediri, as far as Tulung Agung, the country is the centre of sugar-culture. Rounding the massive volcano-complex of the Kelud, Kawi and Ardjuno the railway or the auto takes us across the splendid plain of Malang. It lies at a higher level than the one of Kediri, hence its deliciously cool climate. East of the last section of the road rises majestically the Tengger with the Bromo, and south of it the Semeru (3676 m.).

Starting from Kediri we see above the rice- and sugar-fields — around the Kelud and Semeru — numerous rubber-estates extending eastward along the south-coast, interrupted only by the sugar-centre of Djatiroto near Lumadjang (largest sugar-factory of Java), and by the Tobacco-centres of Djember and Besuki. Rounding the south-side of Idjen-plateau we reach the railway near Banjuwangi: the eastpoint of Java facing the west-point of Bali; distance from Batavia 900 km. as the crow flies.

The attentive traveller has many an opportunity — even on a flying-trip — to note the extraordinary density of population in this remarkable agricultural area. A few data may confirm the impression.

According to the latest census (1920) Java numbers more than 35 million inhabitants on an area of 131.403 sq. km.; density: 266 per km.$^2$. When comparing it with some East-Asiatic areas (figures quoted from the important paper by the director of the central bureau for Statisticsentiled: "Agriculture and Density of Population in Java", Meded. No 8, 1922 by J. VAN GELDEREN) it will appear that the latter — though surpassing all other agricultural areas in the world — cannot bear comparison with Java. Japan has 135 souls per sq. km. The provinces of China (with their millions of inhabitants) of which we possess reliable data, fluctuate between 125 and 200. Bengal alone approaches Java very closely: 223. Next come Oudh in Br. I. (201) and Madras (112). The Philippines have only 33, Siam 12, Ceylon 63. We have seen before that Java's density of population is by no means everywhere the same.

The provinces Kedu, Pekalongan and Surabaya number 400 per km.²; Djokjakarta, Surakarta, Semarang, Madura, Banjumas and Cheribon: 300—400; Kediri, Pasuruan, Rembang and Batavia: 200—300 Preanger-regencies, Besuki and Bantam: 200 and less.

In 1922 Java and Madura numbered 453 districts, 65 of which had more than 600 inh. per sq. km., 26 % of the population then lived in 99 districts of 500, whereas 110 districts numbered less than 200 per sq. km.

The density of population in Java depends entirely on the extent of the food-provision area. Java disposes of about 10 million bouws (bahus) (one bouw = 2/3 h.a.) tilled by the native population, almost equally divided between wet rice-fields (sawahs) and dry ones (ladang). One million of bouws is cultivated by Europeans, 3 mill. are covered with djati-forests and primeval woods.

Of the remaining 3 mill. — after deducting the village-area and the area taken up by railways, tramways, roads, water-works etc. — there is not much left for agricultural purposes; extension of culture in Java seems next to impossible. During the past 40 years this extension has been unable to keep pace with the increase of population, which according to recent data has doubled in 63 years. Ever since 1890 there has been a shortage of rice, which has to be supplied by import; consequently the Dutch Government has to face a knotty population-problem, and to solve it by means of extension of irrigation (higher yield per unit-area), seed-selection, experiments with manuring-systems, encouragement of emigration both within Java and to the other islands, and finally industrialisation, the remedies now en vogue. From the above it becomes apparent that — as to emigration — Sumatra attracts the greatest attention. However — for the present — emigration cannot solve the problem; it is true: more than 200.000 Javanese are employed in the culture-centre of Sumatra's East-Coast, and the Government has succeeded in settling about 5000 families in a colony in South-Sumatra (Lampong Districts), but these attempts are of no significance with a view to a total population of 35 millions! Within Java emigration — not a spontaneous one — is chiefly directed towards Besuki and Madiun.

A social phenomenon — as is often seen — bids fair to bring relief. Of late native agriculture seems to free itself from its ancient production process. The natives take a daily increasing share in the production for the world-market (in other terms: change of production for home consumption into one yielding a surplus). By this process the income of the native will normally be increased so as to solve the problem. In this respect the subjoined data are very instructive (quoted from the Report of the Central Bureau of Statistics, No. 61, relative to the export-

Top of Wilhelmina Mountain above the snow-line in New-Guinea.

Rice field on the slope of the Gedé (West-Java).

Coffee estate (South-Sumatra).

Government Cinchona-estate Tjinjiruwan (West-Java).

crops of the N.E.I. in 1927). In the tabular statement will be found, starting from 1894 — all the export-values, side by side: 1.— the share of the native population; 2.— of the foreigners.

**Export of the agricultural products from the European estates, and from native agriculture in millions of guilders.**

| Year | Java | | | Outer Provinces | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Estate | Native | Total | Estate | Native | Total | Estate | Native | Total |
| 1894 | 116 | 7 | 123 | 21 | 10 | 31 | 137 | 17 | 154 |
| 1902 | 123 | 13 | 136 | 23 | 24 | 47 | 146 | 37 | 183 |
| 1913 | 231 | 43 | 274 | 70 | 55 | 125 | 301 | 98 | 399 |
| 1917 | 339 | 31 | 370 | 89 | 54 | 143 | 428 | 85 | 513 |
| 1921 | 516 | 65 | 581 | 133 | 101 | 234 | 649 | 166 | 815 |
| 1925 | 625 | 101 | 726 | 300 | 429 | 729 | 925 | 530 | 1455 |
| 1926 | 541 | 70 | 617 | 276 | 324 | 600 | 817 | 400 | 1217 |
| 1927 | 589 | 86 | 675 | 243 | 298 | 541 | 832 | 384 | 1216 |

The above figures speak volumes! We only need call attention to the fact that — since 1925 in the Outer Provinces — native production exceeds in value the estate-production owing to the participation of the natives in the rubber-production especially in Sumatra (Djambi, Tapanuli, Palembang) and in Borneo (N.W. Borneo and Ulu-Sungei, see Plate IV). The figures show clearly how strongly this participation may contribute to the increase of income.

The far greater density of population in Java as against Sumatra is due in the first place to the inferior quality of the volcanic products in Sumatra and Bantam; from the latter province in an easterly direction their basicity increases constantly. The far greater rainfall in the West-Archipelago caused, moreover, a more intense lixivation of the soil. The volcanic products — carried by the great rivers to the extensive eastern plains — lacked the fertilizing properties of the Java-tufa. Besides — the tertiary strip of land surrounding the foot of the Barisan covers a far greater area than in Java.

Inside the above-mentioned volcanic ares are grouped the islands in which recent volcanism appears in a lesser degree.

Among them — in the western part of the Archipelago — we must mention in the first place the islands east of Sumatra, which appear to be a continuation of the Malay Peninsula. They are the Riouw-Lingga group, Banka, Billiton and the Karimata-group. Parallel with them lie

the Anambas- and the Tambelan-islands, which, again, close up with the Karimata-group, while the North- and South-Natuna isles (lying farther northward in one line with Borneo's south-west coast) are the last of the row stretching North-South. Here is the tin-ore area of Malacca with the two principal tin-producing islands of the N.E.I.: Banka and Billiton. In Banka the industry is entirely in the hands of the Government; in Billiton there is a mixed system. The tin-ore of Singkep is exported as such, and for a large part reduced in Malacca. This area makes the N.E.I. one of the principal tin-producers in the world with (1925) a yield of more than 31.000 tons (Bolivia: 54.000; Malacca: 46.000). Together with B. and M. the N.E.I. supply 90 % of the world-production.

Though the working of the mines would not pay, tin-ore is found in all the other islands of this row, which as is but natural have developed less as an agricultural area. Banka has a pretty brisk culture of pepper, practised by Chinamen who have stopped working in the mines, and in the Riouw-Archipelago the culture of Hevea is making progress.

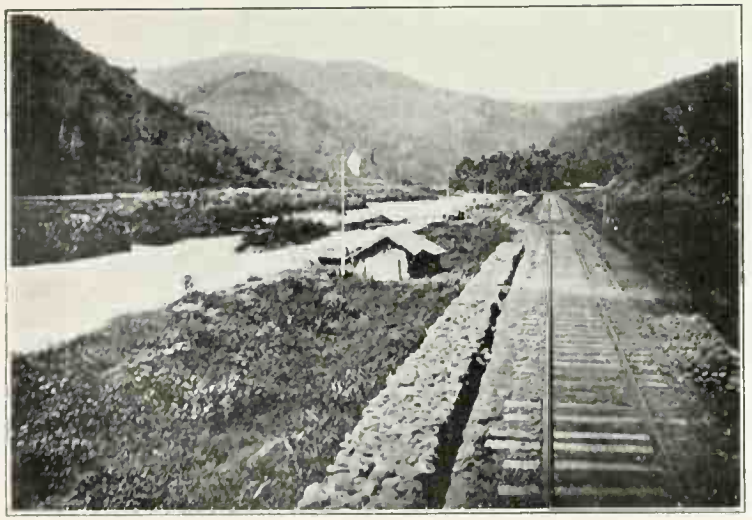
East of these islands lies the large island of Borneo (535.638 sq. km.). According to the latest census (1920) it had a population of 1.626.000 souls, which shows that it is not one of the "blessed" isles of the volcanic arc. In fact — recent volcanism is lacking there. The interior is — for the larger part — covered with primeval woods. (See Plate IV.) The great river-banks are centres of population, likewise the roads up country follow the great rivers. The western part is taken up by the basin of the Kapuas, which flows across a vast delta into the sea near Pontianak on the west-coast. The southern part is taken up chiefly by the basin of the Barito and its affluents, which meets the sea near Bandjermasin on the south-coast, while the eastern part comprises the Kutei-basin. This river has built up a vast delta near Samarinda on the Straits of Makassar. Borneo's eastern part — like East-Sumatra and North-Java — is one of the coal- and oil-areas of the N.E.I., Balikpapan — south of the Kutei-delta — being the main export-harbour. Further northward there is another oil-area: Pulu Tarakan. At the S.E. point lies Pulu Laut with the coal-port Setagen.

From whichever side we approach Borneo, we see the yellow silt-water carried far into the sea by the great streams. At several miles' distance from the coast we detect a marked line of demarcation between the translucent sea-water and the yellow river-water. When approaching the coast and sailing up the river we are surrounded by strand-swamps with nipapalms and rhizophores. It takes a long time to reach the higher inhabited banks.

Nevertheless Borneo, too, has its prosperous, more densely populated

Primeval forest in the caldeira of the Lawu (Java).

Clearing for cultivation in primeval forest in South Borneo.



Preanger rail-road near Tjiandjur (West-Java).

River market in South Borneo (Ulu Sungei).

regions: Ulu-Sungei N.E. of Bandjermasin, density: 32 per sq. km., one of the chief native-rubber producing areas. Besides: the northern part of W. Borneo formerly a mining-district of Chinese emigrants, is now an important pepper- and native-rubber area; density: 12 per s.q. km.

Together with Sumatra Borneo belongs to the typically Asiatic half of the N.E.I. Archipelago. This brings us to the second fact, that strikes the attentive student of the phys. map of the N.E.I. Together with Java, Borneo and Sumatra enclose the Sunda-sea, which nowhere-shows a depth exceeding 100 m., forming the Sunda-shelf. A similar shelf lies between New-Guinea and Australia, including the Aru-islands: the Sahul-shelf. Between these shelfs lies the extremely dislocated area of the Eastern-Archipelago with deep basins, the oddly shaped Celebes and Halmaheira, and the numerous lesser islands above mentioned.

Celebes — the largest of them — is separated from Borneo by the deep Makassar-Straits (average-depth: 2000 m.); all the seas around the island show considerable depths up to the very coast. Three great bays penetrate far into the island: Gulf of Boni (south), of Tolo and Tomini (east) giving the island its queer shape.

Its situation on the out-skirts of the eastern, more isolated and less developed E.Arch., and the fact that it borders upon the W.Arch., intersected by sea-routes of the world-traffic (Straits-Sunda and -Malacca), has made Celebes one of the most prosperous areas of the E.half. On the S. peninsula (W. coast) lies the important harbour of Makassar, the staple-town for products from the east: spices, shells, forest-products — especially rotan — and Indian corn from Celebes itself. Besides — in recent times (the Archipelago having become again — as of old — a transit area) Makassar is visited by ships on their way to Australia or — through Makassar-Straits — to China and Japan.

Celebes covers an area of 188.237 sq. km. and has a population of 3.100.000 souls. The greatest density of population is found in the areas with a fertile volcanic soil; in the south of the S. peninsula we find 60—100 per sq. km.; in the Minahassa, the N. volcanic area of the N. Pen. the density is 30. Only a small amount of european capital is invested in Celebes-cultivation.

Among the islands further east we need only mention the ancient spice-producing areas (nutmeg, cloves): the Banda-group, the Amboina-group (south of Ceram) and the isles west of Halmaheira. Owing to the falling-off of the spice-prices, the diminished consumption, and the competitions of other spice-producing countries — these islands — formerly so prosperous — are now of little importance.

The Key- and Aru islands are rich in valuable species of wood; Ceram possesses an oil-area.

Of the large island of New-Guinea the western half is N.E.I. territory with an area of 416.194 km.², and (census 1920) 200.000 inhabitants, i.e. scarcely 0,5 per sq. km., a figure which proclaims the island to be one of the least cultured ones of the Archipelago. Of late years the Government has taken numerous measures to develop land and people. The natural conditions are however unfavourable: lack of recent volcanism and a low level of civilisation.

The general aspect of the island is characterized by the central mountains; the Mount Wilhelmina (4600 m., see Plate III) rises into the zone of eternal snow [1]). South of the mountain-range extends the broad southern plain, in which the Digul has dug out its bed, with difficulty winding its way to the sea and splitting up into many branches. It is navigable far up its course for small steam-craft.

North of the central mountains (Snow-M.) lies the central plateau: the basin of the head-rivers of the great Mamberamo-stream, which — after forcing its way through the VAN REES Mountains — flows towards the N. Coast. The northern coastal plain is far narrower. West of this part of the island lies the strongly indented „Vogelkop" (Bird's head), united with the central part by a narrow isthmus. The indentations forming the Vogelkop are the Geelvink-bay, fenced off by a double row of islands (the SCHOUTEN-group and the JAPÉN-group), and the MAC'CLURE bay (W.), separated from the Geelvink-bay by a narrow isthmus.

New Guinea and the islands lying on the "Sahul-Shelf" show many characteristics of the Australian region.

This second fact apparent on any physical map of the Netherlands Indies, shows us three several regions, each with its own geographical character. The W. Archipelago shows the arcs of islands lying on the "Sunda-Shelf" Sumatra and Java, with an abrupt descent towards the Indian Ocean, consequently with an insignificant coast-formation. The volcanoes raise their cones higher than 3000 M. on the high mountain-ridges near the Indian Ocean. They filled up the longitudinal valleys, covered the plateaus and the inner slopes, which are much less steep on the side of the vast plains formed in the Sunda-Sea and afterwards indented by the great river-systems of E. Sumatra, N. Java and W. and S. Borneo. In this shallow sea — on the inner side of the Sunda-Arc and parallel to it — lie the islands which are a continuation of the Malay Peninsula, showing a much older physical aspect and a far less fertile soil. On the E. side this shallow sea is bordered by the extensive island of Borneo, whose great river-systems surround it with a belt many

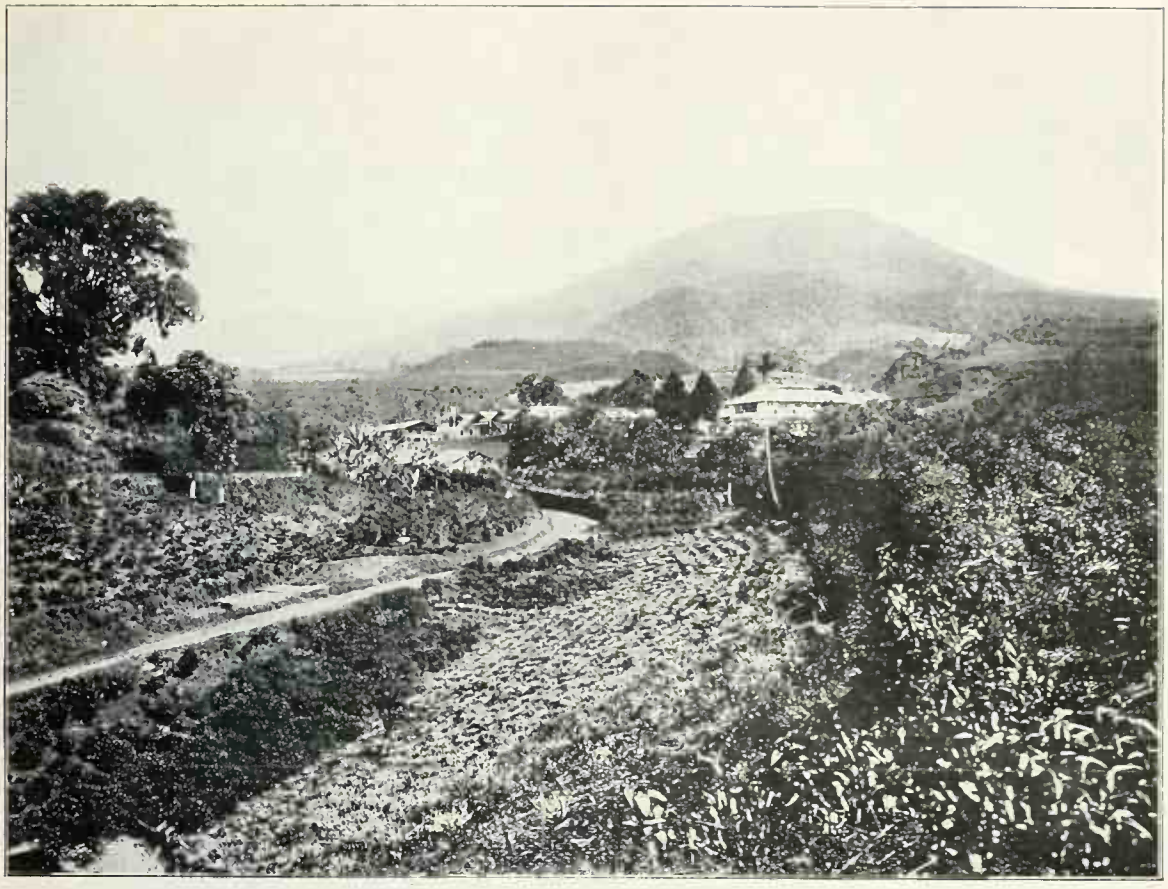
[1]) Such is also the case with Carstens-Peak (W. of the Snow-M.). The snow-line is at 4350; at the Wilhelmina-top at 4475 m. ab. s. l.

miles wide of silty yellow water, behind which the transitional stages between water and land hide so to say in the overgrown coastal swamps. We have to sail up the river a good distance before we see the mountains covered with the typical tropical "Rain-woods".

Prosperity however becomes apparent both in the volcanic regions and in the vast hills and plains surrounding the mountain-ranges on the inner side. Here Man has more than anywhere else changed the face of the country. Here — high up the mountain-slopes and on the plateaus — lie the European and Native estates. Numerous roads intersect the whole country. The practised eye soon detects the irrigation-works, which — above all — give to the country the typical character of a prosperous tropical agricultural area, which — during the past century — has peaceably developed a high degree of prosperity, thanks to the "Pax Neerlandica" and the favourable geographical conditions.

Borneo — even at first sight, when approached from the sea — forms a striking contrast with this picture, except in the above-mentioned regions (S.E. and N.W.) where of late a great economic progress can be noticed. The island lacks the favorable conditions, which — elsewhere — enabled Man to transform the primeval landscape into a first-rate agricultural.

Separated from the W. Archipelago by Makassar-Straits follows the disconnected area between the Sunda- and Sahul-shelfs, characterized by far smaller islands surrounded by very deep seas. Plains of any considerable area are of course not to be expected here: only Bali, Lombok, N. and S. Celebes remind us of the "blessed isles". In the extreme East (on Banda, Ambon, Ternate) we meet with vestiges of former prosperity owing to the profitable spice-trade, but this prosperity was not intensive enough to have lasting consequences. Typical of this region are the splendid groups of coral-islands, which could form in the translucent blue water, hardly if at all muddied by the small river-systems of the little islands. When we enter these parts from the side of the Java- (Sunda-) Sea, we see them emerging from the clear blue water in a variety of shapes and aspects. Often the bottom of the sea shows as a garden of the most gorgeous colours, in which as gorgeously coloured fishes swim about. Sand-banks — scarcely reaching to the surface and washed by the tides — are waiting for the incessant labour of the reef-builders, that will make them fit for the vegetation of coco-palms; the same vegetation that lends an indescribable charm to the older coral islands. In the interior of the islands — high up the mountains — we meet with the oldest ranges of calcareous rocks and "cuirasses" of coral-reefs that have assumed the most fantastic shapes through the influence of the rains, they impart to this region a quite exceptional character, and its quaint



Tea-estate Goalpara (West-Java).

Main road on the West coast of Sumatra in the gorges of the Anei-river.

beauty is enhanced by the imposing volcano-silhouettes encircling the deep basins of the inner arc.

Having reached the third part of the Archipelago (the "Sahul-shelf") with New Guinea), one might believe oneself taken back to the western part, particularly Borneo. Here we find the same desolateness in the coastal swamps stretching from the coasts far away up country and giving no hint of the high central mountaineous region behind them. The landscape is no more than in the western part adorned here by reefs; only a few shoal- and strand-reefs surround the coasts of the Aru-islands, some sections of the W. New-Guinea coasts, and the northern islands-groups.

There is another factor lending to the two E. Parts of the Archipelago a different aspect from the W. half. This element is closely connected with the third essential condition that strikes the observer upon closer study of the map. The equator traverses the Archipelago in its full extent from W. to E. Via the Batu-islands (W.) it enters the Archipelago, and N. of Padang it crosses Sumatra, which is practically halved by it. Via the Riouw-group it reaches Borneo, near Pontianak on the Kapuas-mouth. Borneo, too, is cut in nearly equal halves. The northern peninsula of Celebes lies just north of the equator, which passes close by the N. coast of New Guinea. To the North the Archipelago extends as far as the islands of Miangas (belonging — acc. to the late arbitral decision — to the N.E.I., as it did before the decision), i.e. to 5° 33′ N.L. Miangas is the most northerly island of the Talaud-group. To the south the Archipelago extends as far as the 10° 35′ S. Lat. (Roti-island in the Outer Arc). So the greater part of it has a S.Lat. From W. to E. its boundaries are defined by the 95° meridian (Pulu Bras, N. of Sumatra-point) and the 141° E.L. Gr. (Fly-river in N.G.). This geographical situation brings this area within the tropical rain-belt, while the slight breadth of the islands (Borneo perhaps excepted) sends the strong influence of the surrounding seas far inland. Generally speaking, the typical character of its climate is uniformity. Dr. C. Braak (The climate of the N. Indies, Vol. I, General Chapters) observes justly: "the lack of incentives caused by weather-changes in other climates, has a relaxing influence on the energy of Man, greater or less according to the individual's constitution — it is true — but all the same *undeniable*. High temperature, abundant downfall of rain, great humidity and soft winds are the chief characteristics of this climate". There are, however two elements bringing about considerable local differences. In the first place: the marked contour variations in the landscape of recent formation, described above. If — horizontally — the differences in temperature are but very slight, vertically they are relatively pretty considerable. The fall of the thermometer

as we proceed up country is from 5½ to 6° per 1000 m. level-change, and — according to Dr. BRAAK — is, again, so regular that the temperature of the higher regions may be pretty accurately deduced from that of the lower ones. The influence of the contour on the rainfall is equally strong. In this respect the maps in Vol. 2 of "Verhandeling No. 14 of the Kon. Magnetisch en Meteorologisch Observatorium at Batavia" are very instructive. The 11th map — showing the yearly rainfall in Java and Madura — will bring out two facts: 1. we see that the areas with more than 6000 m.m. rainfall are found only in the higher regions; 2. in West- and Central-Java these regions lie N.W. of the mountain-ranges and volcano-summits, whereas — in East-Java, starting from Willis-volcano — they lie on the S.E. side, with the exception of the Ardjuno-Kelud-complex which lies open to the N.W., whereas to the S. E. it lies in the "rain-shadow" of the high Semeru-Tengger range.

The above statement necessitates consideration of the phenomenon of the *monsoons* under the influence of the Asiatic Continent, and — as regards the E. and S.E. Arch. — of the Australian Continent. In fact the chains of high mountains compel the dry S.E. trade-wind blowing from the dry deserts of Australia strengthened by the monsoons, to give up its water.

This single fact suggests the general one: both in the plains and on the mountains the break between the dry period and the spell of rain is far more marked in the E. and S.E. than it is in the W., and it is this element that accentuates the disparity between E. and W. This phenomenon stands out very distinctly in the S. Pen. of Celebes, where — in the W. coastal plain of Makassar — the rainy period coïncides with the normal season, i.e. with the south-hemisphere summer, whereas — as a consequence of the high ranges — this period is relatively dry in the coastal plain of Sindjai at some 30 km.'s distance (E.); on the other hand — the rainy period coïncides here with the E. monsoon, i.e. in the s.-hemisphere winter.

Contour and rainfall have had another consequence bearing upon the social-economic development of the Archipelago relative to the use of water-power for purposes of agricultural industry, and — of late years — of traffic and illumination. The variability of the water-level in the rivers — it is true — often necessitated the construction of costly water-works, still systematic research (the Water-Power and Electricity Service was instituted in 1917) has had satisfactory results, and wide prospects are now in view. In 1926 the total energy generated by water-works was K.W. 55.700.

The subjoined figures will illustrate the importance of the N.E.I. as an agricultural area. They refer to the year 1926, and are quoted from the above-mentioned "Mededeeling van het Centraal Kantoor voor de Statistiek, No. 61".

**EXPORTS IN METRIC TONS.**

| PRODUCE. | World-Export. | Neth. Indies | |
|---|---|---|---|
| | | in metric tons | in % of the world-export |
| Rubber | 645.545 | 205.163 | 32 |
| Sugar | 24.915.818 | 1.972.771 | 8 |
| Coffee | 1.314.247 | 74.124 | 6 |
| Tea | 369.581 | 61.700 | 17 |
| Cinchona | ± 12.000 | 10.643 | 89 |
| Copra, oil etc. | 1.510.639 | 403.041 | 27 |
| Palmoil-kernels | 710.497 | 15.609 | 2 |
| Agave (Sisal, Cantala, Magey) | 208.675 | 38.328 | 18 |
| Cocoa | 473.696 | 1.060 | 0,2 |
| Coca-leaves | — | 1.044 | — |
| Capok | ± 22.500 | 17.722 | 79 |
| Pepper | 34.355 | 24.494 | 71 |

The influence of the elements above-mentioned stands out very clearly if we arrange the products under the head of *regions lying in the volcanic inner arc* (including the two other volcanic areas: S. and N. Celebes), and *islands without (hardly) any recent volcanism*; likewise — on close consideration — the other causes of disparity between the E. and the W. A. may be traced.

**RUBBER.**

(Here we must take into consideration that this product appears not to be overparticular as to the nature of the soil)

| | | Production in K.G. | | |
|---|---|---|---|---|
| **Volcanic.** | | | | |
| Sumatra: Plantage- (Estate-) product. | 1926: | 61.995.554. | Native: | 44.031.000 (dry) |
| Java: „ „ „ | | 27.836.337 | „ | nil |
| Menado (N. Cel.) „ „ | | 30.000 | „ | nil |
| South-Celebes: „ „ | | 40.237 | „ | nil |
| Amboina and Ternate: „ „ | | 9.681 | „ | nil |
| **Non-Volcanic.** | | | | |
| Riouw-group: „ „ | | 2.407.766 | „ | 6.984.000 |
| Borneo: „ „ | | 1.794.314 | „ | 32.686.000 |
| Other Islands: „ „ | | nil | | nil |

## SUGAR.

### Volcanic.

Java: in tons of 1000 K.G.

| | |
|---|---|
| Cheribon ..... | 72.058 |
| Indramaju ..... | 32.469 |
| Pekalongan ..... | 191.123 |
| Semarang ..... | 91.442 |
| Banjumas ..... | 81.564 |
| Kedu ..... | 58.441 |
| Jogjakarta ..... | 215.356 |
| Surakarta ..... | 190.500 |
| Madiun ..... | 85.523 |
| Surabaija ..... | 332.817 |
| Kediri ..... | 250.840 |
| Pasuruan ..... | 291.884 |
| Besuki ..... | 78.754 |

Neither *Sumatra* nor *West-Java* produce any sugar (see text), no more do the other islands.

## COFFEE.

### Volcanic Area.

| | | Production in tons of 1000 K.G. |
|---|---|---|
| Java and Madura: | Estate-produce. 1926: 31.029 | |
| | The share of East-Java in this production is 29.391 = 95 % | |
| Sumatra: | Estate-produce | 4 151 |
| Menado: | ,, ,, | 492 |
| S. Celebes: | ,, ,, | 13 |
| Amboina and Ternate: | ,, ,, | 27 |
| | Native-produce: In 1926: 48.819. | |

This comes to 55 % of the total produce of the N.E.I., which — native produce included — amounted to 87.797. This native produce is — for the greater part — grown in the Outer-Provinces (in the volcanic areas). Apart from the "fancy-coffee" grown in Celebes, Timor and Bali — native-coffee is chiefly produced in *Sumatra*.

### Non-Volcanic Area.

Only *Timor* grows a small quantity of "fancy-coffee; export in 1926: 77.

## TEA.

**Volcanic Area.** Production in tons of 1000 K.G.

Tea-production is limited to Java and Sumatra.

| | | |
|---|---|---|
| Java Estate-produce in 1926 ..... | 38.980 = | 62 % |
| Sumatra „ „ „ 1926 ..... | 8.558 = | 13,6 % |
| Native-tea („opkoop-thee") excl. in Java ..... | 15.382 = | 26,4 % |
| | | 100 % |

## CINCHONA (KINA).

**Volcanic Area.**

Excl. in *Java* and *Sumatra*. Of the estates 127 lie in *Java* (94 in West-Java). The 12 estates of the Outer provinces lie all of them in *Sumatra* (6 on the West-Coast).
In 1926: 10.643; *Java* came in for: 9.317 tons of 1000 K.G.

**Non-Volcanic Area**: nil.

## COPRA, COCONUT-OIL, ETC.

All Provinces export these products.

## TOBACCO.

**Volcanic Area.**

| | | |
|---|---|---|
| Sumatra (Deli). Estate-produce in 1926 ..... | 20.049.676 | K.G. (Leaf) |
| Java „ „ „ 1926 ..... | 18.481.995 | „ (Leaf) |
| | 20.526.924 | „ (Krossok) |

The Java-production includes more than 1.000.000 K.G. Leaf and nearly10.000.000 „ Krossok native produce

**Non Volcanic.**

Production for the World-market..... nil.

In conclusion we supply the figures concerning the density of *population* according to the Census of November 1920, and according to the administrative sub-division then in use. We annex the figures concerning *Area* and *Density*.

## JAVA AND MADURA.

| PROVINCES | AREA IN SQ. K.M. | EURO-PEAN | NATIVE | ORIENTAL FOREIG-NERS | TOTAL | DENSITY PER SQ. K.M. |
|---|---|---|---|---|---|---|
| Bantam ..... | 7.912,83 | 599 | 892.032 | 4.760 | 897.391 | 113,41 |
| Batavia ..... | 11.704,12 | 37.138 | 2.628.142 | 122.065 | 2.787.345 | 238,15 |
| Preanger Reg. .. | 21.414,67 | 16.198 | 3.772.971 | 21.463 | 3.810.632 | 177,94 |
| Cheribon ..... | 5.605,80 | 2.020 | 1.680.112 | 29.646 | 1.711.778 | 305,35 |
| Pekalongan ..... | 5.668,67 | 3.217 | 2.243.002 | 22.352 | 2.268.571 | 400,19 |
| Semarang..... | 8.348,44 | 15.144 | 2.680.208 | 42.064 | 2.737.416 | 327,90 |
| Rembang ..... | 7.288,20 | 1.764 | 1.641.859 | 20.191 | 1.663.814 | 228,29 |
| Surabaya ..... | 5.891,60 | 21.579 | 2.396.520 | 42.081 | 2.460.180 | 417,57 |
| Madura ..... | 5.473,66 | 814 | 1.736.651 | 6.353 | 1.743.818 | 318,58 |
| Pasuruan ..... | 8.782,32 | 9.509 | 2.211.235 | 20.487 | 2.241.231 | 255,20 |
| Besuki ..... | 10.080,61 | 3.048 | 1.484.555 | 11.262 | 1.498.865 | 148,69 |
| Banjumas ..... | 5.587,53 | 2.083 | 1.754.512 | 10.934 | 1.767.529 | 316,33 |
| Kedu ..... | 5.493,54 | 5.204 | 2.434.694 | 16.693 | 2.456.591 | 447,18 |
| Djokjokarta .... | 3.145,80 | 4.885 | 1.270.594 | 7.336 | 1.282.815 | 407,79 |
| Surakarta ..... | 6.029,38 | 5.003 | 2.029.843 | 14.701 | 2.049.547 | 339,93 |
| Madiun..... | 5.884,60 | 2.450 | 1.586.008 | 6.197 | 1.594.655 | 270,99 |
| Kediri..... | 7.118,75 | 4.633 | 1.990.538 | 16.822 | 2.011.993 | 282,63 |
| Java-Mad.-Total. | 131.430,52 | 135.288 | 34.433.476 | 415.407 | 34.984.171 | 266,18 |

## OUTER PROVINCES.

| | | | | | | |
|---|---|---|---|---|---|---|
| Sumatra's W. Coast ..... | 46.695,41 | 4.147 | 1.505.209 | 12.884 | 1.522.240 | 32,60 |
| Tapanuli ..... | 388.227,91 | 763 | 839.515 | 3.307 | 843.585 | 22,07 |
| Benkulen ..... | 25.886,8 | 660 | 253.639 | 2.841 | 257.140 | 9,93 |
| Lampong's Distr. | 28.268,4 | 600 | 229.608 | 3.695 | 233.903 | 8,27 |
| Palembang ..... | 85.918,05 | 1.710 | 810.353 | 15.941 | 828.004 | 9,64 |
| Djambi..... | 48.480,94 | 246 | 228.975 | 4.123 | 233.344 | 4,81 |
| Sumatra's E. Coast ..... | 93.500,24 | 7.882 | 1.042.930 | 146.742 | 1.197.554 | 12,81 |
| Atjeh & Dep. .. | 55.549,78 | 2.538 | 718.444 | 15.383 | 736.365 | 13,26 |
| Riouw & Dep. .. | 32.391,73 | 481 | 199.615 | 23.026 | 223.122 | 6,89 |
| Banka & Dep. .. | 11.781,70 | 668 | 85.774 | 67.699 | 154.141 | 13,08 |
| Billiton..... | 4.849,5 | 404 | 39.188 | 28.990 | 68.582 | 14,14 |
| Borneo West ... | 147.210,62 | 839 | 535.516 | 69.047 | 605.402 | 4,11 |
| Borneo S. and E. | 388.427,38 | 2.725 | 998.282 | 19.592 | 1.020.599 | 2,63 |
| Menado ..... | 63.761,72 | 2.250 | 745.985 | 12.457 | 760.692 | 11,93 |
| Celebes & Dep. . | 124.478,10 | 3.818 | 2.329.123 | 14.704 | 2.347.645 | 18,86 |
| Amboina ..... | 44.995,70 | 2.635 | 271.879 | 3.452 | 277.966 | 6,18 |
| Ternate & Dep.. | 33.143,40 | 724 | 146.391 | 2.130 | 149.245 | 4,50 |
| New Guinea .... | 416.194,00 | 237 | 193.856 | 1.367 | 195.460 | 0,47 |
| Timor & Dep. .. | 68.402,88 | 761 | 1.140.708 | 5.191 | 1.146.660 | 16,76 |
| Bali & Lombok . | 10.546,42 | 332 | 1.556.154 | 8.528 | 1.565.014 | 148,39 |
| Total outer Prov. | 1.768.710 | 34.420 | 13.871.144 | 461.099 | 14.366.663 | 8,1 |

## APPENDIX I.

In the N.E.I. ports entered from foreign countries

| In the year | Total entered ships. | Under dutch flags | Under foreign flag. | Total tonnage in M³. |
|---|---|---|---|---|
| 1925 | 19.974 | 4.289 | 15.685 | 23.742.579 |
| 1926 | 20.446 | 4.551 | 15.895 | 26.095.728 |

Departures from the N.E.I. ports to foreign countries.

| In the year | Total number of ships | Under dutch flag | Under foreign flags | Total tonnage in M³. |
|---|---|---|---|---|
| 1925 | 15.626 | 3.881 | 11.745 | 22.666.536 |
| 1926 | 16.497 | 4.239 | 12.258 | 25.216.603 |

The evidence about the share of foreign flags in the shipping of the N.E.I. may be seen from the following figures

*A.* Flagssharing in the inter-insular traffic of the N.E.I. (in %).

| In the year | The Netherlands | England | Germany | Japan | U. S. of A. |
|---|---|---|---|---|---|
| 1925 | 79 % | 12 % | 3 % | 3,5 % | 0,7 % |
| 1926 | 79,5 % | 12,8 % | 3 % | 3,0 % | 0,6 % |
| | K. P. M. 43 % | | | | |

*B.* Flagssharing in the traffic between the N.E.I. and foreign countries (in %).

| In the year | The Netherlands | England. | Germany. | Japan. | U. S. of A. | Scand. |
|---|---|---|---|---|---|---|
| 1925 | 45 % | 34 % | 5,0 % | 5,0 % | 2,0 % | 3,3 % |
| 1926 | 46 % | 35 % | 6,3 % | 4,2 % | 2,4 % | 3,1 % |

The total tonnage of the fleet of the three greatest Dutch shipping Companies amounted to:

*A.* De Koninklijke Paketvaart Maatschappij (K. P. M.) had in 1928: 106 ships with a total tonnage of 191.822.

*B.* De Maatschappij Nederland had in 1928: 10 mailboats and 31 cargo-boats, with a total tonnage of 313.704, 2 mail-boats; 4 cargo-boats were laid down.

*C.* De Rotterdamsche Lloyd had in 1928: 8 mail-boats and 31 cargo-boats, with a total tonnage of 370.325; 2 mail-boats were laid down.

## APPENDIX II.

Survey of the shipping-conditions in the most important N.E.I. harbours.

| Harbour | Year | Outward bound ships | | Homeward bound ships | |
|---|---|---|---|---|---|
| | | Number | Tonnage in M³. | Number | Tonnage in M³. |
| Tandjong Priok en Batavia .. | 1925 | 4.963 | 13.677.156 | 4.965 | 13.718.748 |
| | 1926 | 5.007 | 14.942.570 | 5.003 | 14 963.319 |
| Indramaju..... | 1925 | 121 | 422.772 | 125 | 422.791 |
| | 1926 | 86 | 433.556 | 85 | 433.559 |
| Cheribon ..... | 1925 | 1.347 | 6.849.037 | 1.348 | 6.860.043 |
| | 1926 | 1.438 | 7.602.495 | 1.438 | 7.593.954 |
| Tegal ..... | 1925 | 875 | 3.471.991 | 874 | 3.471.846 |
| | 1926 | 846 | 3.345.701 | 843 | 3.345.497 |
| Pekalongan ..... | 1925 | 649 | 2.568.280 | 651 | 2.577.303 |
| | 1926 | 574 | 2.904.364 | 569 | 2.895.133 |
| Semarang ..... | 1925 | 2.813 | 12.554.985 | 2.816 | 12.599.307 |
| | 1926 | 2.698 | 13.470.674 | 2.693 | 13.427.261 |
| Surabaja ..... | 1925 | 6.207 | 13.267.367 | 6.208 | 13.234.807 |
| | 1926 | 5.677 | 13.769.450 | 5.674 | 13.854.466 |
| Pasuroean ..... | 1925 | 1.558 | 2.774.343 | 1.562 | 2.793.377 |
| | 1926 | 1.533 | 2.782.774 | 1.527 | 2.755.388 |
| Probolinggo ..... | 1925 | 2.528 | 3.537.498 | 2.539 | 3.537.870 |
| | 1926 | 2.756 | 3.861.162 | 2.747 | 3.860.940 |
| Panarukan ..... | 1925 | 3.318 | 2.932.179 | 3.331 | 2.932.512 |
| | 1926 | 3.374 | 3.022.341 | 3.364 | 3.022.092 |
| Banjuwangi ..... | 1925 | 2.385 | 1.722.267 | 2.392 | 1.722.348 |
| | 1926 | 1.983 | 2.031.184 | 1.979 | 2.031.125 |
| Tjilitap ..... | 1925 | 169 | 1.291.449 | 167 | 1.281.060 |
| | 1926 | 199 | 1.528.431 | 201 | 1.551.937 |
| Telokbetong ..... | 1925 | 384 | 1.222.309 | 389 | 1.224.044 |
| | 1926 | 458 | 1.620.696 | 459 | 1.629.270 |
| Emmahaven en Padang ..... | 1925 | 1.726 | 2.705.238 | 1.709 | 2.697.812 |
| | 1926 | 1.449 | 2.620.692 | 1.453 | 2.629.914 |
| Sabang ..... | 1925 | 836 | 6.248.480 | 838 | 6.265.885 |
| | 1926 | 968 | 7.579.866 | 961 | 7.554.830 |
| Belawan Deli ..... | 1925 | 2.228 | 6.106.246 | 2.234 | 6.103.756 |
| | 1926 | 2.099 | 6.903.697 | 2.093 | 6.902.132 |
| Palembang ..... | 1925 | 1.033 | 1.834.809 | 1.025 | 1.860.420 |
| | 1926 | 1.163 | 2.319.070 | 1.175 | 2.316.713 |
| Balikpapan ..... | 1925 | 1.546 | 3.997.135 | 1.549 | 4.006.443 |
| | 1926 | 1.643 | 4.430.344 | 1.652 | 4.423.007 |
| Makassar ..... | 1925 | 5.365 | 4.885.008 | 5.396 | 4.910.670 |
| | 1926 | 5.431 | 5.706.687 | 5.458 | 5.712.932 |

# GEODESY AND TOPOGRAPHY IN THE NETHERLANDS EAST INDIES

by Ir. J. H. G. SCHEPERS,
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and Dr. Ir. F. A. VENING MEINESZ,
*Professor of Geodesy at the University of Utrecht.*

The Geodetic Survey of the Netherlands East Indies is carried out by the Topographical Service. The following report by Prof. Ir. J. H. G. SCHEPERS, Chief of the Triangulation Brigade, gives a summary of its activity during the last years.

The Topographical Service forms a part of the army under the command of a superior officer, mostly a colonel. Its staff consists of 32 officers or civilians ranking with them, 154 non-commissioned officers or civilians of that rank, 494 native surveyors, draughtsmen, photographers, calculators and heliotropists.

The Service includes: the direction and the establishments situated at Batavia and the field-forces subdivided into brigades and detachments. At Batavia are the Head-office, the Geographical section, the printing-office, the instrumentsmakers-workshop and the sales-room of maps. The brigades and detachments include a triangulation-brigade, a training-brigade, three revision-brigades in Java, and in the other islands of the Archipelago four brigades for topographical surveying and four detachments for land-revenue surveying.

The task of all these subdivisions is sufficiently indicated by their names; the revision-brigades have to revise both the topographical and the land-revenue maps of their section of Java.

After these general remarks we may now give a more detailed description of the various activities of the Topographical Service.

**Triangulation.** The triangulation of Java was begun in 1861 by Prof. Dr. J. A. C. OUDEMANS and this work is now finished with the exception of the revision of the tertiary triangulation. The triangulation of Sumatra was begun in 1883, of Celebes in 1911, of the Sunda archipelago in 1912,

of Bangka in 1917 and of Ambon in 1918. The triangulation of Sumatra is finished except in Acheen (Atjeh); that of Celebes, the Sunda archipelago and Bangka is still going on.

At all triangulation points concrete pillars are built to denote their exact position. The principal stations situated on the highest mountaintops form a triangulation chain or system. The exact position of this system in latitude, longitude and azimuth is determined at one or more orientation stations by means of astronomical observations with a mean error of $\pm$ 0".10. The primary angles are measured with 27 cm. micrometer-theodolites (SCHREIBER's-method), the mean error being $\pm$ 0".4, as calculated from the station-adjustments, and $\pm$ 0".7, as calculated from the closing errors of the triangles. The base-lines in Java were measured with a Repsold apparatus, the new base-lines in Sumatra, Celebes and Bangka with invar-wires of 24 metres; their relative distance is $\pm$ 400—600 km. Each base-line is measured twice with two wires, the mean error varies from $1 : 4 \times 10^6$ to $1 : 12 \times 10^6$ of the base-length. Before and after each base-line was measured, the length of the wires was determined at Sèvres; the mean error in the adopted length of the wires is about $1 : 10^6$. The length of the first side of the principal triangulation is deduced from the base-length by a double-rhomboidal system with a mean error of $\pm$ $1 : 3 \times 10^5$.

The base-line at Padang (Central-Sumatra), which was measured in 1883 with a steel-tape and which was suspected to be incorrect, was remeasured in 1927 with invar-wires; the triangulation of Sumatra can now be computed in conformity to the Java-system, so that in due time a single triangulation-system of about 35° will extend along the equator from the North point of Sumatra to the eastern parts of the Sunda archipelago.

Single secondary stations, or groups of 2—4 of them, are attached to at least 3 principal stations; the angles of these secondary systems are measured with a 18—21 cm. micrometer-theodolite in 6 reiterations. The single tertiary stations are attached to 3 principal or secundary stations, the angles being measured with the same instruments in 2—4 reiterations. The distance of the tertiary stations varies with the scale of the mapping from 4—12 km.

The height of the stations is determined with the theodolite.

**Astronomical observations.** In the flat, swampy parts of Sumatra and Borneo, covered with primeval forests, triangulation would entail a great deal of expense; therefore the place of the stations in these parts of the Archipelago is determined by astronomical latitude and longitude observations, made by special astronomical expeditions (West-Borneo

1886—1895, South-Sumatra 1902—1906, East-Sumatra 1922—1925, 1927). Time is determined by observations of a star E and W near the prime vertical, latitude by circum-meridian observations of 2 stars S and 2 stars N. The West-Borneo and South-Sumatra expeditions made all observations by ear and eye, and longitudes were determined by chronometer-transports. The East-Sumatra expeditions made use of portable chronographs of Nardin and longitudes were determined by radio-time-signals from Malabar, controlled at the Royal Magnetical and Meteorological Observatory at Weltevreden (1922—1923) and at the Bosscha Astronomical Observatory at Lembang (1924, 1925, 1927) by observers of the Triangulation brigade. In 1927 the rythmic vernier signals were introduced, the coincidences being observed by COOKE's impersonal method.

The mean error in the latitude and in the longitude, determined by radio-signals is $\pm$ 0".5, but in the longitudes determined by chronometer transport this error may exceed 2".

A difficulty adhering to the astronomical observations for surveying purposes is the unknown deflection of the plumbline, which at some stations probably attains a value of $\pm$ 10". Therefore the astronomical stations are chosen at considerable distances (20—40 km); more stations would not be of any use.

When the orientation of the Java triangulation-system was introduced into the Sumatra triangulation system, the position of the triangulation-stations in Sumatra with regard to the astronomical stations was much improved.

The present state of the triangulation and of the astronomical observations is shown in fig. 1.—

**Precise levelling.** In 1925 the precise levelling in Java was begun. The projected loops are shown in fig. 2; as the levelling will be carried out along the principal roads, which are of course rather scarce, the length of most of the loops amounts to 300—400 km. The loops are subdivided into sections of $\pm$ 1 km.; every section is levelled twice in different directions. The utmost care is taken to eliminate systematic errors: until now the only systematic errors, which have been traced, were refraction-errors and a small vertical movement of the staves, which rise when placed on foot-pins and sink when placed on foot-plates.

At the end of 1927 the levelling of the loops I, Ia and II was finished; the mean accidental error in the double levelling of a kilometer was $\pm$ 0.6 mm, the systematic error $\pm$ 0.2 mm. The closing error in a loop of $\pm$3 50 km. did not exceed 8 mm, even in loop II, where the height of the marks varied from zero to 900 m.

During the levelling of loop 1 in 1927, a rise of a considerable part of the earth's-crust (± 25 mm) was observed, probably caused by the eruption of Krakatau.

In future two levelling parties will be sent out every year, so that the whole program can be finished in about 10 years.

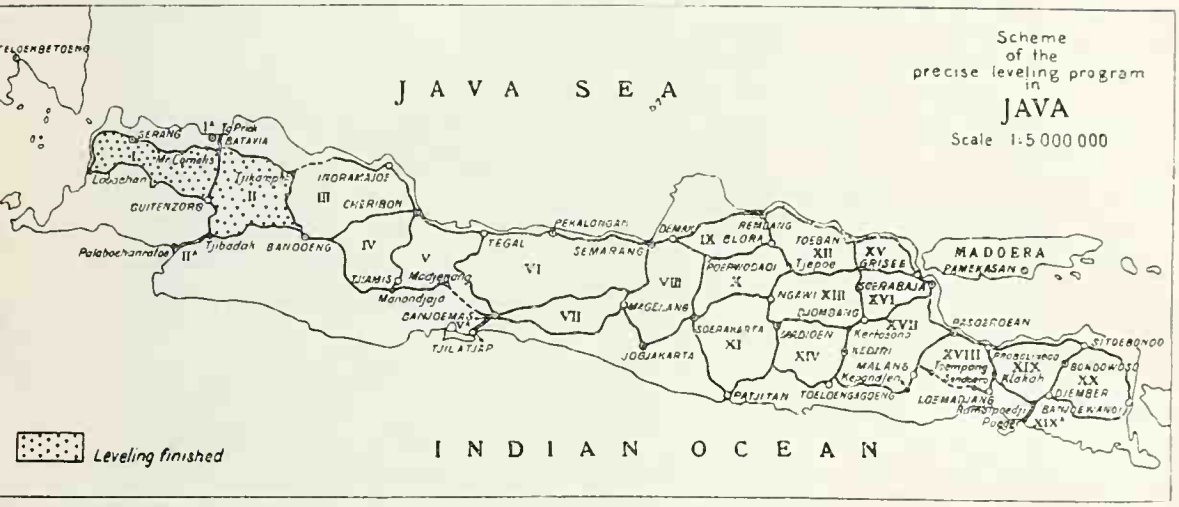



Fig. 2.

**Topographical survey.** The area given to a brigade to survey is divided into "polygons", varying in size from 25 to 100 square kilometres (10—40 square miles), according to their topographical nature and the scale of the map. The survey of the boundary traverses (as far as possible roads and other natural features) is performed with great care by the best surveyors and the results are adjusted to the triangulation marks. The polygon is then entrusted to the care of the younger surveyors, who begin by subdividing it by the survey of smaller roads and field paths; next they survey all paths, rivers, brooks and other details that will have to be put in the map in accordance with its scale.

The boundary roads are measured with theodolite and chain (or tape); internal measurements are made with the "boussole tranche montagne", by means of which distances and heights may be measured on the tachymeter method.

The height of every point above the plane of comparison is also determined and indicated on the map by contours. After all measurements have been plotted, the contours must be joined up according to the nature of the country, for which purpose the surveyor consults the sketches made in the surveyor's book, after which he again traverses the area, taking the map with him.

The amount of work which an experienced surveyor can accomplish in an area with many details, may be estimated from 6 tot 7 square kilometers (2½ square miles) per month on a scale of 1 : 25.000. In a flat country with few details more work can be done and this is also the case when a smaller scale is chosen.

The surveys in Java are made to revise the existing maps. The great cultural development and dense population (267 inhabitants per square kilometer, 685 per square mile) requires a continual revision of the survey to keep the map up to date.

Photogrammetry is not yet used for topographical surveying. An experiment, made in 1921—1922 with terrestric stereo-photogrammetry gave no satisfaction economically; even in the most open areas in Java, large parts of the map had to be completed by ordinary survey.

To give an idea of the annual rate of progress, it may be stated that in 1927 3380 km² were revised in Java; in the islands outside Java 10988 km² were surveyed and mapped while sketch maps were made of 6983 km². The state of the topographical survey at the end of 1927 is shown in fig. 3.—

**Landrevenue-survey.** The work for the registration of landed property in the Dutch Indies is done by a separate (civilian) service, but that necessary for the land-revenue records, is the task of the topographical service. Special revenue-survey maps on an large scale (1 : 5.000) were prepared for the whole of Java and Madura, while for parts of the Southern and Eastern divisions of Borneo, of Sumatra and Celebes, and for the islands of Bali, Lombok and Sumbawa such mapping is in progress.

The results of the land-revenue survey are utilized for the preparation or the revision of the topographical detailed sheets. The land-revenue survey itself is revised every 10 years.

In 1927 701.476 h.a. were revised in Java, whilst 51.696 h.a. in Java and 264.494 h.a. in the other islands were surveyed for the first time.

Of late, experiments have been made with air-photogrammetry for land-revenue survey on the scale 1 : 5.000, the photos being taken with nearly vertical camera-axis, and reduced to horizontal photos on the correct scale by employing the rectifying-apparatus of Roussilhe.

**The maps.** The projection used for the topographical maps is the polyhedric projection with sections of 20′ × 20′, the sections being projected to the plane by the conform conic projection, each section on a separate cone which is tangent at its mid-parallel. On the scale 1 : 100.000 every section is reproduced on one sheet; on the scales 1 : 50.000, 1 : 25.000, 1 : 5.000 the sections are subdivided by parallels

and meridians into respectively 4, 16 and 100 equal parts, each part being reproduced on a separate sheet.

It may be mentioned, that, for artillery purposes, the new topographical sheets of Java are provided with a division in trapezia by parallels and meridians; the sides of these trapezia have a relative distance of ± 1 km. on the scales 1 : 25.000 and 1 : 50.000, and of ± 4 km. on the scale 1 : 100.000.

The following rule applies to all maps in which the mountains are indicated by contours: the difference in height between two successive contours bears a constant ratio to the scale of the map, viz: the two thousandth part of the scale in metres.

All detailed sheets of Java are mapped on the scale of 1 : 25.000 or 1 : 50.000.

In the islands outside Java, where the need of good trustworthy general maps is greater than that of detailed sheets (the preparation of which would take a much longer time) a map is at once prepared on a smaller scale, as in Southern Sumatra, where the scale of 1 : 100.000 is generally made use of. In the survey of the East Coast of Sumatra and of Celebes the scale is generally 1 : 200.000 and only the economically important areas are surveyed with a view to a map of 1 : 100.000 or 1 : 50.000.

For sketch maps of little-known districts and for general maps of the islands of the Archipelago the scales of 1 : 250.000, 1 : 500.000 and 1 : 1.000.000 are frequently used.

In the *Geographical section* the maps drawn by the brigades are collected, checked and got ready for reproduction. The data are utilized for the preparation of the various general maps of the Archipelago, its islands or subdivisions and of the "carte internationale du monde". In the case of regions, which have not yet been surveyed, the data are systematically collected from charts, from sketches made by civil service officials, military patrols, explorers, from periodicals or books and are worked up into sketch maps, which are published as soon as occasion arises.

The topographical and typographical merits of the maps of the Topographical Service were recognised at various international exhibitions by awards of honor and gold medals.

**The reproduction-office.** The printing of the maps takes place in the reproduction-office, divided in a drawing section, a photographic, a lithographic and two printing sections (litho- off-set, roto and typo). For the principal colours of detailed sheets, and of military- and sketch-maps, photolithography is made use of. For the topographical survey

maps on the scale of 1 : 100.000, the principal colours are generally engraved on stone and transferred to other stones, which are used in the printing press.

Of late "offset" printing has also been used for various drawings and maps.

The photographic section has 2 built-in cameras, in which the operator can move when focussing on frosted glass and when fixing the wet collodion plates, which generally measure 90 by 90 cm or 80 by 110 cm. Besides these, there are a number of large bellow cameras the focussing-screen of which is placed on rails in front of the drawing. The largest plates that can be used in these measure 80 by 100 cm.

The process block division produces about 3000 autotypes and line-blocks every year.

There is also an installation to reproduce by rotogravure (depressed surface printing) by means of machinepress.

In the lithographic section there are 3 lithographic machine-presses and 7 offset-presses, further 11 lithographic offset- and zincographic handpresses, with the necessary auxiliary machinery.

The typographic section is fitted up for letterpress-printing on maps and for block-printing for illustrated work; it contains 5 machine-presses and 4 plate presses.

The number of copies produced by the reproduction-office in 1927 in shown by the following figures:

| | |
|---|---|
| For the topographical service ..... | 1.759.589.— |
| For other service branches ..... | 2.340.739.— |
| Total ..... | 4.100.328.— |

The above synopsis of the activities of the Topographical Service by Prof. SCHEPERS will, we hope, convince the reader that it has played a great part in the development of the archipelago. Until now these activities have chiefly been restricted to the practical work of surveying and mapping, which is of course most important and urgent in colonial territories, which like the Netherlands East Indies, have developed so amazingly during the last twenty years. Perhaps in times to come it will be possible to devote also part of its activities to scientific geodetic, geophysical and geomorphological research, for which these islands are an interesting subject.

A first step in this direction has been made by the execution of the precise levelling in Java and by the observations at the Bosscha Observatory at Lembang for the world longitude determination, carried out by officers and engineers of the staff of the Triangulation Brigade. We

may further mention that the Topographical Service has been invited by the Netherlands Indies Astronomical Society to coöperate for the observation of the movement of the pole at the Bosscha Observatory; this observatory is to become the equator station for the control of this movement.

Other research-work of which interesting results might be expected, would be for instance: gravimetric survey, geodetic control of the relative movement of some of the islands in the eastern part of the archipelago, determinations of the plumbline-deflection, etc.

A beginning has been made for the maritime gravimetric survey in the archipelago by the present writer, who made gravity determinations on board the submarine H.M. K.XIII during its voyage from Holland via Panama to Java in 1926, and during a subsequent voyage in February 1927 south of Java, both undertaken in the service of the Netherlands Geodetic Commission. The liberal assistance lent by the Netherlands Navy has made these observations possible and there is every reason to hope that subsequent requests for similar investigations will likewise be granted. The radio time-signals during these voyages were provided by the Wireless Service of the Netherlands Indies, and were controlled by officers and engineers of the Triangulation Brigade at the Bosscha Observatory.

Fifteen observations were made in the archipelago during the last part of the first voyage and twenty-six during the second south of Java. The observations of the second voyage have been arranged in four profiles perpendicular to the length-direction of the Java-deep. Observations have also been made in the following harbours; Amboina, Banda, Bima, Surabaya, Batavia. The gravity stations of these voyages are indicated on map Nr. 1.

The results show great disturbances of equilibrium in the earth's crust, of which the meaning is not yet clear and it is therefore desirable to continue the research in order to make further investigations. An extension of the research over the whole area will allow to study the relation of these disturbances to the geological and topographical features in its entirety and this may lead to a better understanding of their nature. To this end plans have been worked out to cover the whole archipelago with a large number of sea gravity stations and it is hoped that afterwards a land gravity survey will be added to it. As this part of the earth's crust is not stable — it forms part of two large geo-synclinal systems — it is probable that the disturbances of equilibrium are caused by the tectonic stresses, working in the crust, and so there is a great chance that the results may give us valuable data about the magnitude and the trend of these stresses.

# TERRESTRIAL MAGNETISM

by Dr. E. VAN EVERDINGEN,

*Director of the Royal Meteorological Institute of De Bilt (Holland) and Professor of meteorology at the University of Utrecht.*

**Magnetic surveys.** After the first magnetic survey of the archipelago 1846—49 by Capt. Ch. M. ELLIOT as a result of British initiative, three surveys have been carried out by Dutchmen, the first 1874—1877 by E. VAN RIJCKEVORSEL [1]), the second 1903—1907 by W. VAN BEMMELEN [2]), the third 1917—1924 by W. VAN BEMMELEN, C. BRAAK and S. W. VISSER [3]). The most extensive survey was that of 1903—1907, comprising about 140 stations, fairly well distributed over the Archipelago; the various observations at other epochs have made the calculation of the secular variations possible. As a result of all these investigations S. W. VISSER was able to publish [3]) maps of Isogonals, Isoclinals and Isodynamics for the epoch 1925.0 and of the average secular variations per annum of declination, dip and horizontal intensity for the period 1905.5—1925.0. Those referring to declination have been reproduced here as Fig. 4 and 5.

**Observations of variations.** Hourly readings of declination were taken from July 1 1867—July 31 1875, photographic registrations of the three elements were started 1878, satisfactory results being obtained from 1882—March 1899, when disturbances by electric traffic caused a temporary interruption. From December 1901, after the removal of the Adie magnetograph to Buitenzorg, the publication of hourly records has been resumed and has been continued regularly since then; a second

[1]) E. VAN RIJCKEVORSEL. Verslag aan Z. Exc. den Minister van Koloniën over een magnetische opneming van den Indischen Archipel 1874—1879, Amsterdam 1879.

[2]) W. VAN BEMMELEN. Observations made at the Roy. Magn. and Meteor. Observatory at Batavia. 30 Appendix I, 1907.

[3]) S. W. VISSER. Isomagnetics for the Netherlands East Indian Archipelago. Epoch 1925-0. Kon. Magn. en Meteor. Observatorium, Batavia. Verhandelingen No. 13, 1925.

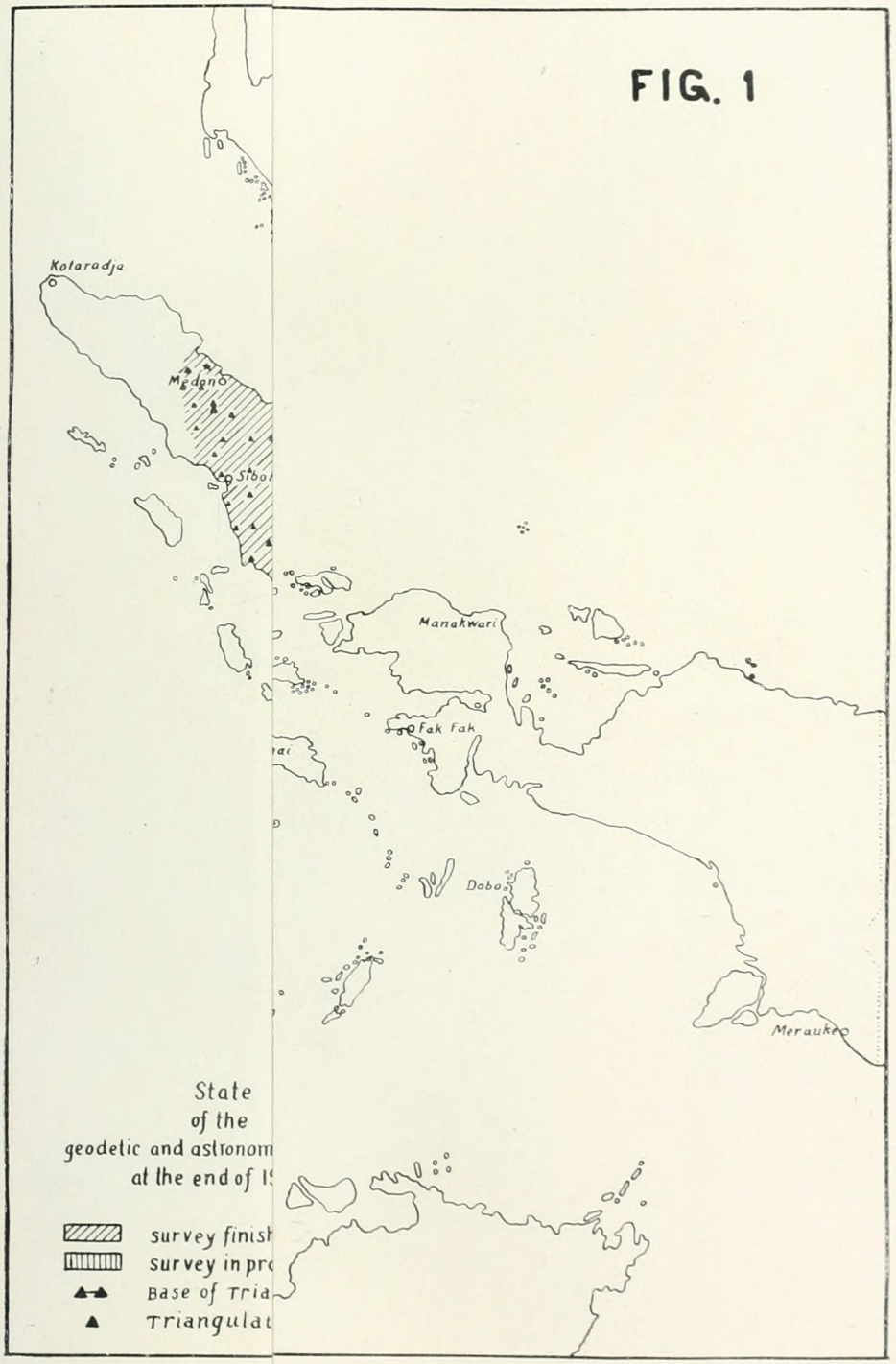
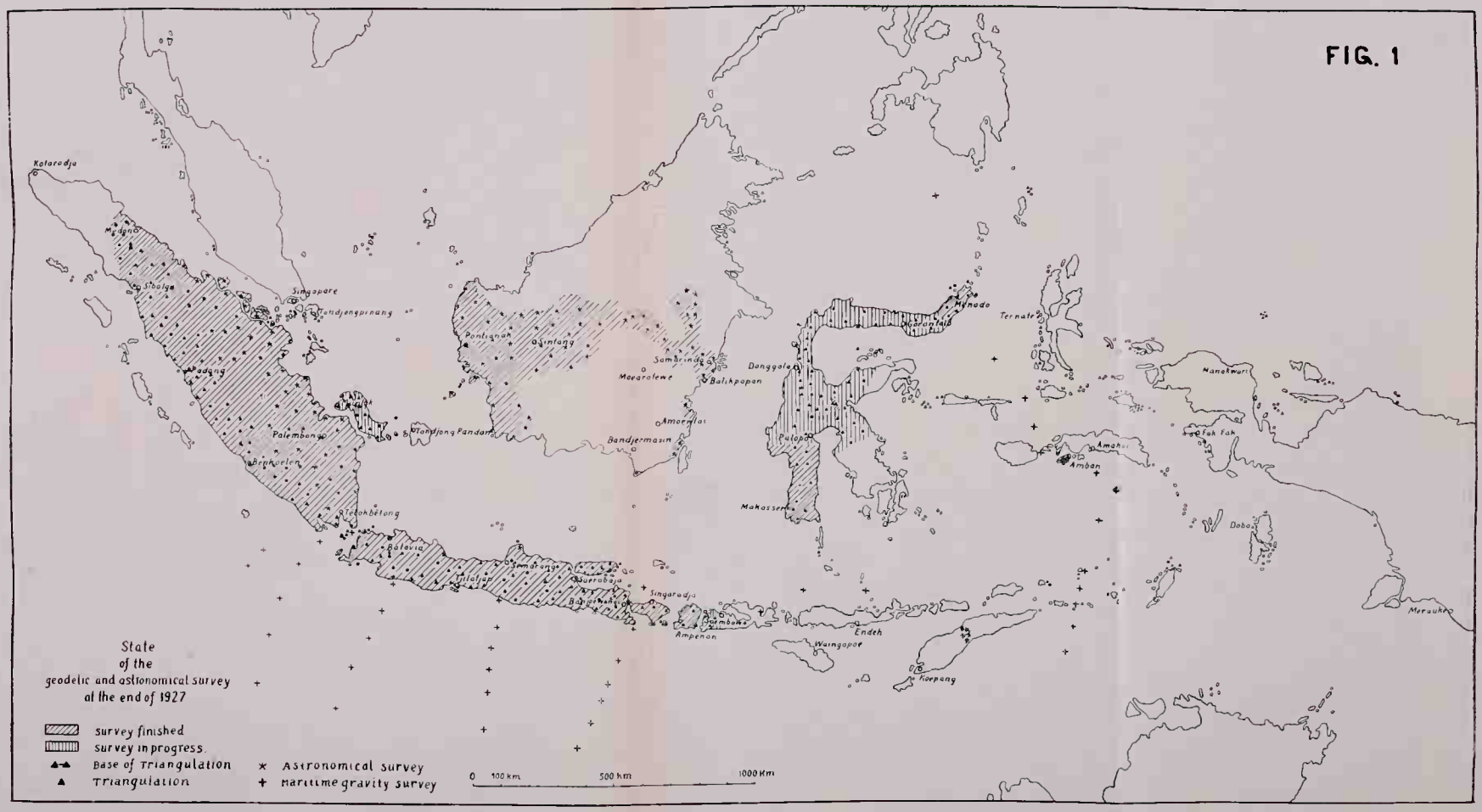


FIG. 1
Kotaradja
Medan
Manokwari
Fak Fak
Dobo
Merauke
State
of the
geodetic and astronom
at the end of 1
survey finish
survey in pr
Base of Tria
Triangulat

FIG. 1


Kotaradja
Medan
Sibolga
Singapore
Pontianak
Samarinda
Balikpapan
Menado
Ternate
Palembang
Tandjongpandan
Bandjermasin
Batavia
Soerabaja
Singaradja
Makassar
Ambon
Endeh
Waingapoe
Koepang
Dobo
Merauke
State of the geodetic and astronomical survey at the end of 1927
survey finished
survey in progress
Base of Triangulation
Triangulation
Astronomical survey
Maritime gravity survey
0 100 km 500 km 1000 Km

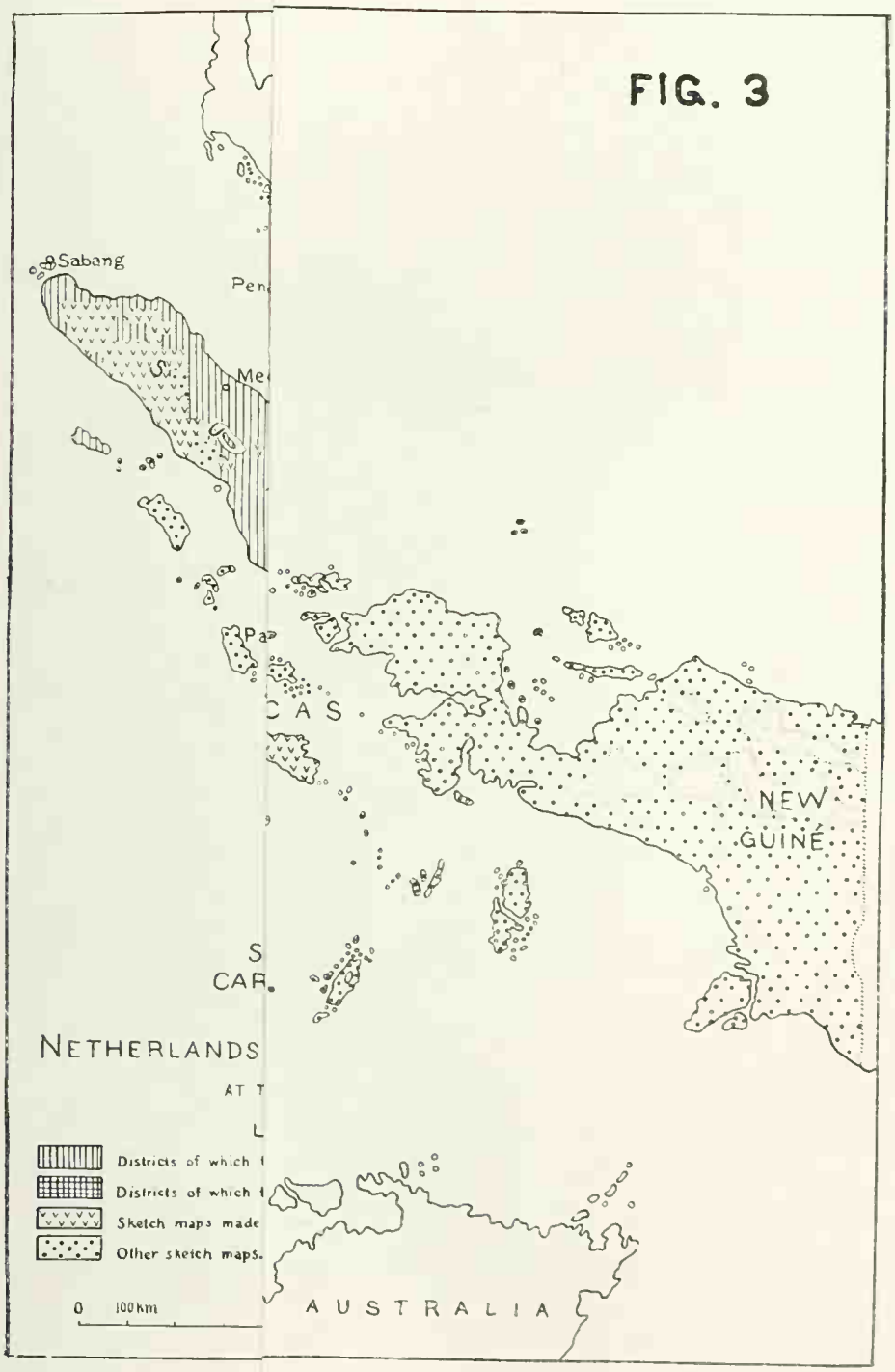
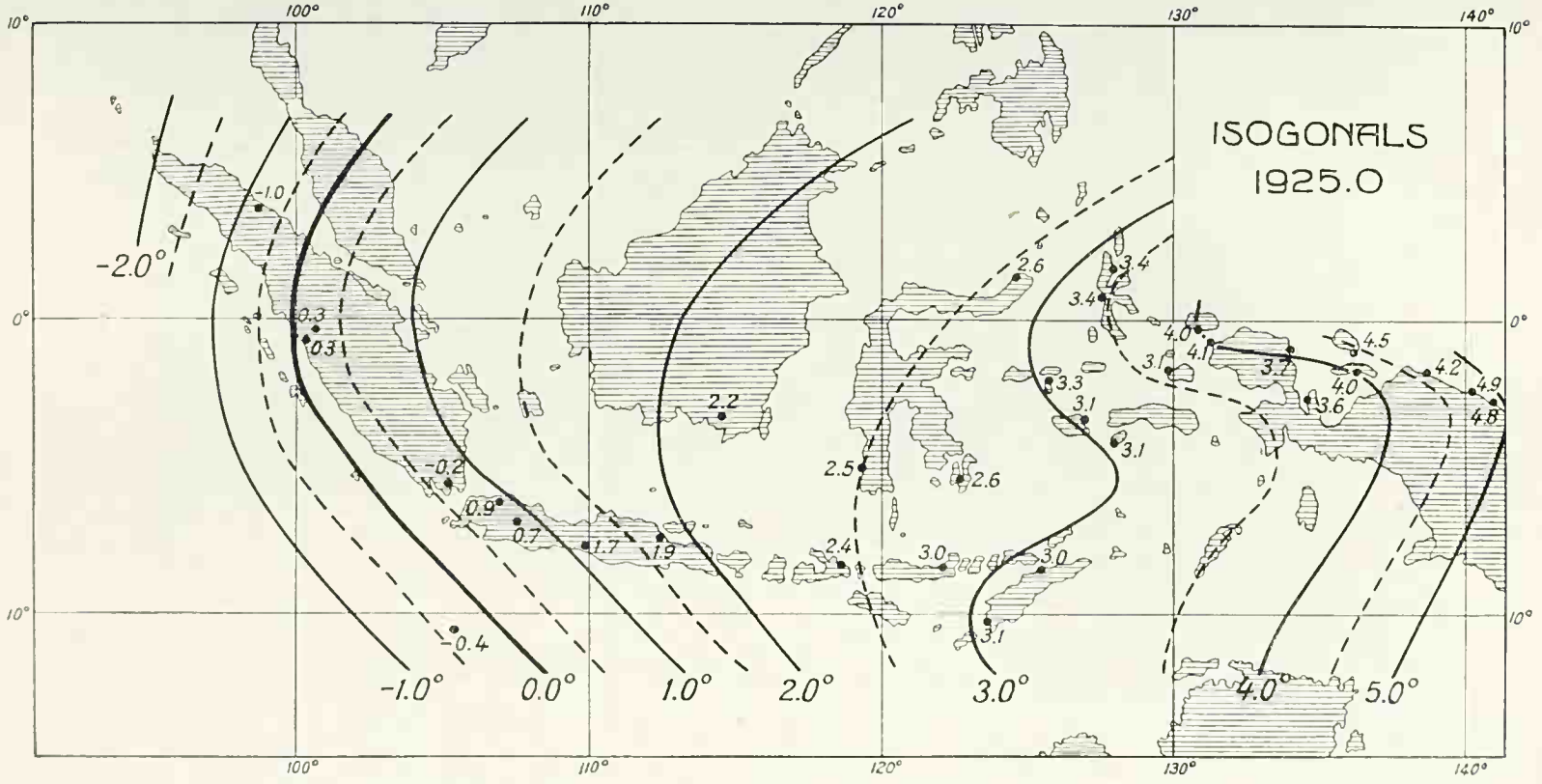

Sabang
NEW
GUINÉ
NETHERLANDS
Districts of which
Districts of which
Sketch maps made
Other sketch maps.
0 100km
AUSTRALIA

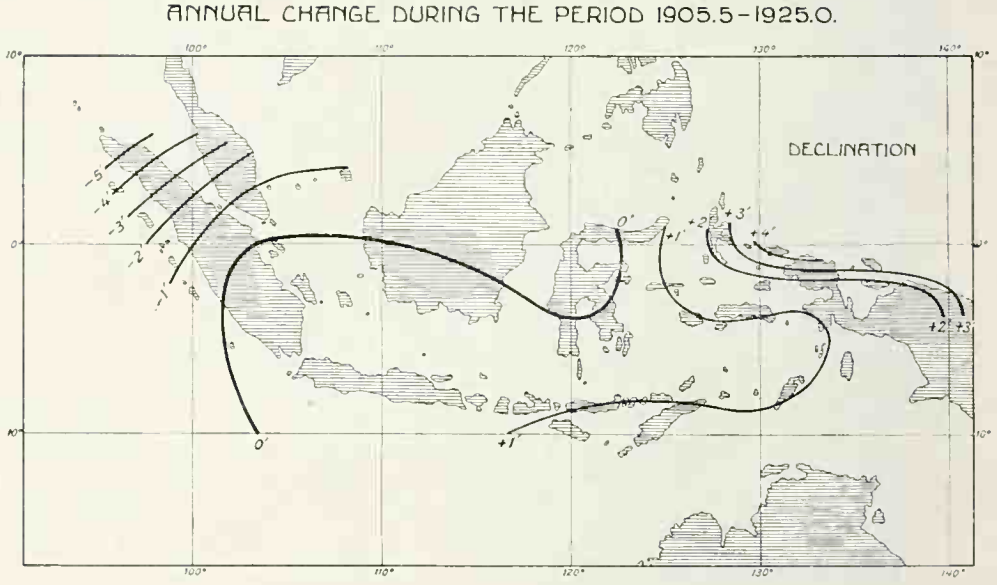
FIG. 3

FIG. 3

PHILIPPINE ISLANDS
Sabang
Penang
MALAY PENINSULA
Medan
Singapore
BRITISH NORTH BORNEO
Brunei
SARAWAK
BORNEO
Pontianak
Padang
Bandjermasin
Menado
CELEBES
MOLUCCAS
Ambon
NEW GUINEA
Makasser
Batavia
Soerabaja
JAVA
(PORTUGUESE)
TIMOR
AUSTRALIA
STATE OF CARTOGRAPHY IN THE NETHERLANDS INDIAN ARCHIPELAGO AT THE END OF 1927
LEGENDA
Districts of which topographic maps exist
Districts of which the maps are being revised
Sketch maps made by technical assistants (surveyors)
Other sketch maps.
0 100 km 500 km 1000 km


ISOGONALS
1925.0
10°
100°
110°
120°
130°
140°
0°
-2.0°
-1.0°
0.0°
1.0°
2.0°
3.0°
4.0°
5.0°
-1.0
0.3
0.3
-0.2
0.9
0.7
1.7
1.9
-0.4
2.2
2.5
2.6
2.4
3.0
3.0
3.1
2.6
3.4
3.4
3.3
3.1
3.1
4.0
4.1
3.1
3.7
4.5
4.0
3.6
4.2
4.9
4.8

Schultz-Töpfer magnetograph being added in 1906. The absolute determinations have always been made in a non magnetic-pavilion at Batavia. At this moment a new removal of this variation pavilion to Kuiper island in the Java sea is being prepared, as an electric railway to Buitenzorg is in course of construction. Besides the hourly values of the three elements in the annals of the Observatory the hourly values of disturbance are also calculated according to the method of J. P. VAN DER STOK, and harmonic analysis of daily oscillations is given




there. S. FIGEE [1]) published an extensive research about the whole series of measurements, comprising also an investigation of the lunar variation.

**Earthcurrents and atmospheric electricity.** During the years 1905—1908 earthcurrents were registered, using telephone and telegraph cables to Billiton, Cheribon, Soerabaja, Macassar, Buitenzorg and Padang during night hours. VAN BEMMELEN's investigation [2]) on the relation of earthcurrents with terrestrial magnetism pointed to a possible connection with the geological composition of the soil in West Java.

[1]) Observations made at the Roy. Magn. and Meteor. Observatory at Batavia. 22, part II, 26 Appendix.

[2]) Proceedings-Kon. Ak. van Wet. Amsterdam 10. p. 512—543 and 782—799, 1908. 11. p. 242—248, 1908.

Regular observations of atmospheric electricity were made during the years 1887—1902 and have been published in the annals of the Batavia Observatory. Of late, this subject has once more received attention in connection with penetrating radiation. This time the investigations have been started at Bandung by J. CLAY [1]), who published results for the potential gradient there and intends to continue his investigation in cooperation with the Observatory at Batavia.

[1]) Proc. Kon. Ak. van Wet. Amsterdam, 30, 1927, p. 1115—1127.

# THE CLIMATE OF THE NETHERLANDS EAST INDIES

by Dr. C. BRAAK,

*Formerly Director of the Royal Magnetical and Meteorological Observatory at Batavia.*

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The most prominent quality of the tropical climate is its monotony, its uniformity from day to day. The sudden changes of temperature and wind, characteristic of the climates in the temperate zone, are absent in the East Indies and the weather hardly counts as a topic of conversation.

Where no oppressive heat is felt, as is the case in the tropical mountains, the climate is the finest an inhabitant of the temperate zone can imagine. Still, in this ideal climate one longs at first for the changes between the mild south and the cold north wind, the regular succession of the seasons, of storm and calm weather. In the long run however, one is no longer aware of this privation, and gets so accustomed to the fine weather, that after a long residence one prefers the Indies to the home country and does not repatriate any more.

The climate of the tropical zone, which covers nearly half the globe, is rather uniform, but its differences are often overlooked by meteorologists and physicians, who, dealing with the influence of climate on man, do not make sufficient distinction between a climate with a mean temperature of 20° C. and another with one of 26°. This difference can only be appreciated by those who, after a residence in the hot tropical plains, visit the highlands with their bracing climate. For instance, when one leaves Batavia, which has a mean temperature of 26°, and visits Bandoeng which has a mean temperature only 4° C. lower, the sensation of oppression, which is felt in the plains, vanishes entirely, and many Europeans, who left Batavia on account of the oppressive heat, feel quite at ease and cheerful at Bandoeng and prefer a stay there to one in Holland with its more inhospitable climate.

Apparently one degree of temperature counts more in the case of temperatures approaching the limit of human endurance, as in the low-lying plains, than at lower temperatures.

This great sensibility to temperature differences involves, that in describing the climate of a tropical country, stress should be laid in the

The Royal Magnetical und Meteorological Observatory at Batavia.

first place on the temperature conditions, and especially on the variation in connection with height, because the variation in a horizontal direction is slight.

**General features of the Indian climate.** The demensions of the islands of the East Indian Archipelago are still small enough to allow of an effective interchange of air with the surrounding seas. Consequently the climate resembles that of the ocean near the equator. Abundant rainfall, light winds, high temperature and high humidity are therefore the principal features of the climate of the Indian plains.

This, however, is only approximately true, the exceptions to the general rule being by no means negligible.

The influence of the continents of Asia and Australia renders the Archipelago the most typical monsoon region in the world. The change of the monsoons causes an annual variation in the climate, which is fairly small in the northern, but considerable in the southern part of the Archipelago.

Added to this seasonal variation are the local differences, which are relatively large on account of the mountainous character of the country, which makes rainfall and cloudiness to a high degree dependent upon the direction of the wind.

Moreover, in successive years differences occur in the force of the monsoons which are closely connected with the general air-circulation. Consequently the differences between the seasons may vary appreciably, so that in some years the farmer will wait in vain for the dry season, whereas in other years he will look out for months and months for the first good shower.

With the exception of the fluctuations of rainfall, the variations from day to day are trifling. Disturbances, such as the low-pressure systems of the higher latitudes, which make the weather very variable, are practically unknown. The deviations of air pressure do not even exceed a few millimetres, and hardly affect the weather.

Strong winds are exceptional. By far the most important are the variations in rainfall, and it is chiefly by the intensity of the tropical cloudbursts that the inhabitants of this land of eternal summer are reminded of the power of the elements.

The variation of the phenomena is very much the same from day to day. When the sun has risen in the clear sky and has stirred the air by its heat, the small cumulus clouds begin to appear, usually at about 9 o'clock; at the same time the monsoon, which had almost completely died down durning the night but had kept blowing in the higher air layers, springs up again. Windforce and cloudiness increase

as the sun climbs higher, the clouds grow denser and darker, pile themselves up to higher and higher levels, till in the afternoon condensation sets in, and the refreshing rain falls down with a pattering sound on the thick foliage, or till, towards the close of a rainless day, the clouds gradually dissolve with the declining force of the sun beams. Then the evening succeeds the short summerday, the sky clears up, the wind abates and the cloudless and calm tropical night begins, bringing relief after the oppressive heat of the day.

The uniformity of the temperature conditions makes the differences between the climate of the higher regions and that of the low plains the more prominent. In addition to the decrease of temperature of from 5½ to 6° C. for a rise of 1000 metres, the climate also changes in other respects with increase of height. In the mountains cloudiness increases and at first also the amount of rain. On reaching higher levels the intensity of the rains becomes smaller, but the total duration of showery weather increases, instead of the heavy tropical cloudbursts light showers becoming more frequent.

The weather is very variable on the high mountain tops. When the air is calm and the intensely radiating sun is not obscured by clouds or fog, one feels almost too hot. But as soon as a fresh breeze springs up and blows away the thin layer of warm air that surrounds the mountain, the temperature may fall several degrees, and one suddenly feels shivery. When the clouds cover the summit and shut out the sunlight, the weather becomes at once chilly and dull, but when the mist has cleared and the atmosphere is again filled with light, the depressing state of the weather changes as if by magic into the merriest summerday.

Thunder is very frequent on the mountain slopes but it is seldom observed on the high tops. The thunderclouds, which originate on the lower slopes, repelled as it were by the mountain, take their course towards the plain. It often occurs that on all sides high clouds tower above the summit, whereas the latter is left free and still basks in the sun.

**Comparison of the climate with that of the neighbouring countries.** Although the heat of the coast plains is far from pleasant, yet the climate compares favourably with that of our neighbours at a little greater distance from the equator.

As a matter of fact, the mean annual temperature decreases as the latitude increases, but the favourable effect of the cooler winter months is more than counterbalanced by the unbearable heat of the hottest summer months. In this case a more equable temperature distri-

bution over the year is better than the more usually praised variety.

We may conclude from the wet-bulb temperatures that there exists on both sides of the equator a zone with more oppressive weather in the hottest month than is found on the equator. The following figures, which represent the mean wet-bulb temperature in the hottest month, may serve as a proof.

| Batavia | Shanghai | Manila | Hongkong | Port-Darwin | Nha-trang (Annam) |
|---|---|---|---|---|---|
| 24°.4 | 24°.8 | 25°.2 | 25°.4 | 25°.4 | 25°.8 |

| Bombay | Madras | Calcutta | Lahore | Hanoi (Tonkin) |
|---|---|---|---|---|
| 25°.9 | 26°.2 | 26°.4 | 26°.6 | 26°.9 |

Whereas at Batavia the maximum heat, although disagreeable, can be endured without too much discomfort, the same cannot be said of most of the other places, at Calcutta for instance the climate is almost unbearable at the most oppressive time of the year.

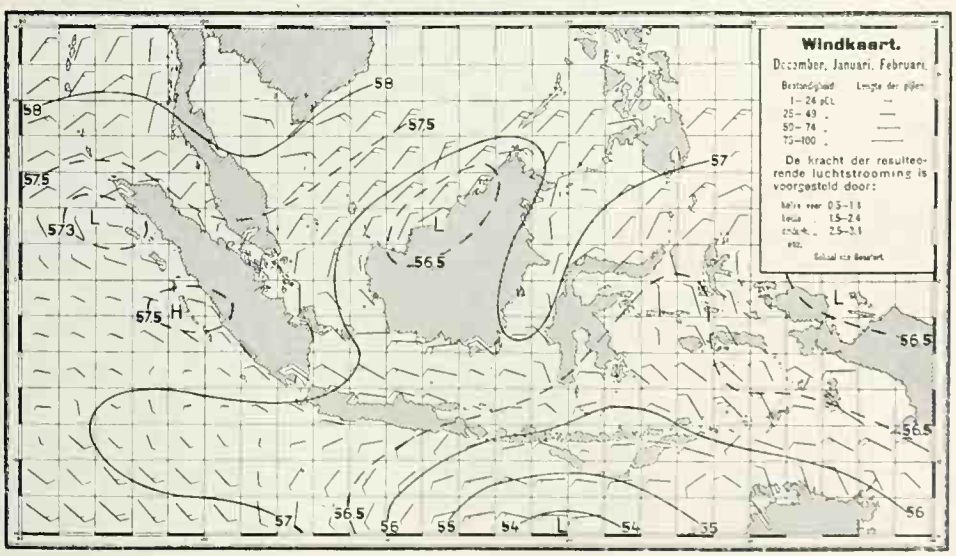
There is still another difference of much importance in favour of the East Indies. It is the fact that, owing to the small distance from the equator, practically no destructive tropical cyclones occur in the Archipelago, and, moreover, the heavy storms of the temperate zone need not be guarded against. Wind spouts can develop a destructive force, but they are so local and therefore so rare, that they need scarcely be taken into account. For these reasons, there is no safer place for navigation at sea than these regions and on land less strong building constructions are sufficient as compared with other parts of the world.

**Observations.** The period of regular and trustworthy meteorological observations begins with the foundation of the Observatory at Bata via in 1866. Under its first director, Dr. BERGSMA, a system of 74 rainfall stations was established in Java and of 44 on the other islands, in addition to the meteorological and magnetical observations, made at the Observatory. The number of these stations has been regularly increased in course of time and at the present moment the Observatory receives the observations from more than 3000 rainfall stations. Dr. VAN DER STOK compiled the observations made on board men of war from 1814 till 1890 and published the results in "Wind and weather, currents etc.", Batavia 1897. Since 1908 a great many observations of the upper air were made, particularly by Dr. VAN BEMMELEN, comprising observations of wind, temperature and humidity up to great heights. As director of the Observatory, VAN BEMMELEN established a system of secondary meteorological stations, distributed over the whole Archipelago, their height ranging from the sea level to a height of 3000 metres, on Mount

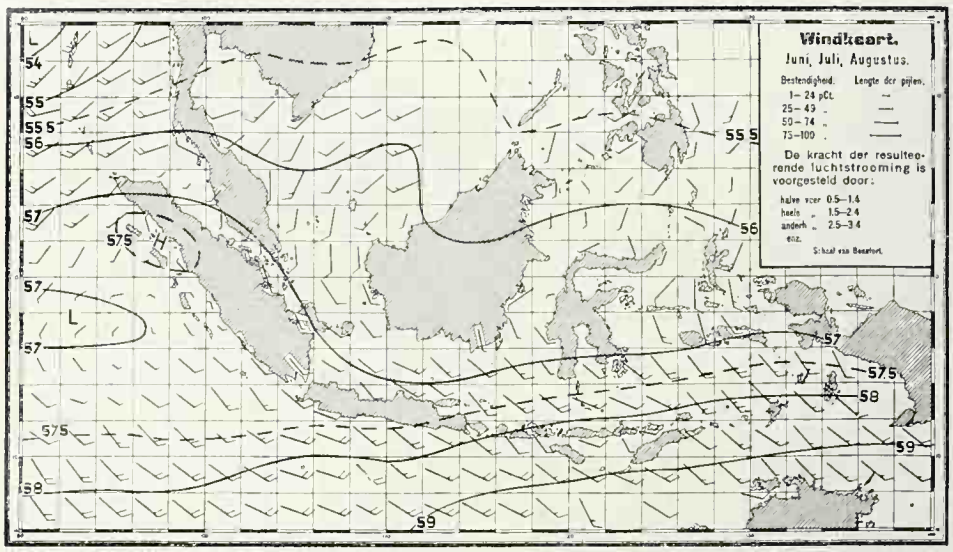
Pangerango. A number of 42 of these was in operation in 1918. These observations provided the material for my treatise on the "Climate of the Netherlands Indies" from which the greater part of the contents of this paper has been taken. Several treatises, based on the rainfall observations, were written by Dr. VAN BEMMELEN and Dr. BOEREMA. Dr. BOEREMA has taken charge of the observations of the intensity of the sunlight; a great many of these are available and are being compiled for publication. A good deal of work has been done with more or less success on the problem of seasonal weather forecasting; Dr. BERLAGE, who took over this investigation during the last two years has made some valuable progress.

**Wind and air pressure.** The monsoons are very well developed in the Archipelago. The trade wind system of the tropical oceans is disturbed by the influence of the continents of Asia and Australia, which in the summer of their hemisphere draw the air from the opposite hemisphere across the equator, thus causing one monsoon season with SE. wind on the southern and SW. wind on the northern hemisphere, and one with NE. wind in the N., passing the equator and changing to NW. in the southern part of the Archipelago. The monsoon changes do not occur exactly at the same time, over the whole region and in various years, most frequently however, in March or April and in November.

Two charts are inserted here, representing the mean air pressure and mean wind direction and force in the west-monsoon months




Air pressure and wind in December-February.




Air pressure and wind in June-August.

December—February and the east-monsoon months June—August, which were compiled at the Royal Dutch Meteorlogical Institute from observations, made on board of ships.

In the open sea the steadiness of the monsoons is fairly great, reaching about 90 % when the east or west monsoon have attained their full development.

In those months the wind system is also very regular, with respect to the wind velocity. The average wind force is remarkably high in those monts, the mean wind velocity observed at 23—28 metres of height on the Indian lighthouses in the open sea being 9 metres per second in the most windy months.

The lightships in the North Sea near the Dutch coast record no higher figure for the mean velocity in the most stormy month. The mean velocity for the whole year is even higher on the Indian lighthouses than on the Dutch lightships, being from 6 to 7 metres per second in the first and from 5 to 6 metres in the second case. How is it possible that in spite of this the wind has the reputation of being generally light in the tropics? We get a satisfactory answer when we take into account that the velocities observed in the Indian seas become smaller when reduced to normal height, and when we consult the wind observations, made on land. At Semarang, quite close to the sea, the mean wind velocity is only 3.0 m. p. s., and at Batavia, at 10 km from the sea it is 1.1 m. p. s., at the mountain station of Tosari 2.2 m. p. s.

A very important fact, in favour of the Archipelago, is the absence

of very strong winds. In a period of 5 years, chosen at random, the highest daily mean of windvelocity was 3.2 m. p. s. at Batavia, against 12.8 m. p. s. at the Dutch Meteorological Institute at De Bilt (Holland), the highest hourly means being 5.3 and 26.0 m. p. s. Whereas on the Dutch coast mean hourly velocities of 32 m. p. s. have been observed, the highest hourly means observed on the lighthouses in the Indian seas are probably not much higher than 16 m. p. s.

This means that the windvelocity hardly ever surpasses that of a fresh gale, the consequence of which is a high degree of security in navigation, in comparison with the regions of the tropical cyclones at some greater distance from the equator, or with the temperate latitudes with their travelling systems of low barometric pressure.

Land and sea breezes have a great influence near the coast, up- and down- valley winds in the mountainous interior. Where the monsoons are light, those winds dominate the whole windsystem. On the west coast of Sumatra the influence of the land and sea breezes extends to a distance of more than 100 kilometres from the shore, in the Java Sea to some 70 km from the Java coast. At the base and on the slopes of the high volcanoes the mountain and valley breezes are usually stronger than the monsoons.

It is quite natural, after what has been said about the wind, that its cause, the differences of air pressure, are relatively small and that the variations in the pressure system are much more regular than in higher latitudes. The insignificance of these changes may be demonstrated by the fact that the highest barometer reading at Batavia, 764.4 mm, does not differ more than 12 mm from the lowest, 752.4 mm. Barometric lows such as occur in temperate latitudes are unknown; the small aperiodic variations which occur are ups and downs of barometric pressure which are met with almost simultaneously over the whole Archipelago.

The absence of great disturbances makes the regular diurnal variation and the variations of long duration the more prominent. The latter, of which those with a period of about 3 years are the mos important, have a great influence on the climate, though their amplitude is only 1 mm from maximum to minimum. These changes are used as a base for a long-range weather forecast.

**Temperature and Humidity.** The average annual temperature at sea level can be fixed at 26° C. for the whole Archipelago, the deviations from this mean value being only a few tenths of a degree for the various stations. The temperature is fairly uniform during the whole year.

There is a slight variation however, lower temperatures occurring in the winter season of the corresponding hemisphere, higher temperatures in the summer season. In July and August the temperature falls about 1.°5 C. from Pontianak and Menado in the north to Kupang and Ambon in the south, in January and February there is a still smaller fall in the opposite direction. Besides this annual variation of winter and summer, the temperature becomes relatively high twice a year in the monsoon changes, shortly after the sun has passed the zenith.

The highest temperatures are observed on the north coast of East Java and in Madura, towards the close of the dry season; Surabaja has a mean temperature of 27°.5 in November.

The lowest temperatures are found in the south east in the dry season; Kupang has a mean temperature of 25°.0 in July. At that time of the year the weather is strikingly cool, when measured by the tropical standard, in the south eastern part of the Archipelago, owing to the cooperation of low temperature and low humidity.

The temperature in the higher zones of the country can be calculated from the sea level temperature with a fair degree of accuracy, by substracting 0.°6 C. for every 100 metres of height. Thus taking 26.°2 as the mean temperature at Batavia (8 m) we find for Bandung (730 m) 21.°9, for Tosari (1735 m) 15.°8, the actual figures being 22.°1 and 15.°9.

One of the principal characteristics of the tropical climate lies in the slight changes of temperature, not only from season to season, but also from day to day. Taking the differences between the mean temperature of the hottest and coolest day at Batavia for every month, we get an average of only 2.°7 C. for this monthly oscillation of temperature. The difference between the highest and lowest daily means of the whole series of observations, being 28.°7 and 22.°3, is 6.°4 only. The average difference for the year is 4.°5.

The principal temperature changes are due to the diurnal variation. The daily oscillation at Batavia is 7.°3 for the whole year, varying from 5.°8 in February to 8.°6 in August and September. In the interior it is generally greater, at Bandung for instance 9.°3 for the whole year, 6.°9 in January and 4.°4 in August.

The highest maximum-temperature has been observed at Sawahan, in Central Java, viz: 38.°6 (October), the lowest minimum temperature —2° was observed on the level parts of the high plateau of Pengalengan (1550 m) in the dry season. Probably still lower temperatures have occurred in sheltered basins of great height during calm dry nights.

Generally speaking, the mean monthly values of relative humidity do not vary greatly. They lie, as a rule, between 85 % and 90 %, with the exception of the dry months in the region with a well-developed

dry season. At the coast stations the mean relative humidity in the driest months varies from 87 % at Tarakan in East Borneo to 67 % at Pasuruan on the north coast of East Java. The highest mean monthly figures are 96 % in September and December on M. Singgalang in Central Sumatra, 95 % in February at Kawahtjiwidei in the mountains of West Java, and 94 % in January on M. Pangerango in West Java.

The lowest yearly average, 77 %, is found at Pasuruan, the highest average, 93 %, on the summit of M. Singgalang, one of the wettest points in the world.

The absolute minimum of relative humidity, 6 %, has been observed on M. Pangerango.

**Rain fall.** The Archipelago is characterized by abundant rainfall. A great part of the mountainous regions receives more than 3000 millimetres a year, and more than 2000 millimetres fall in large areas of the coast plains. A yearly amount of less than 1000 millimetres is quite exceptional and has been observed at only two stations on the N. coast of East Java, at Waingapu on the isle of Sumba, and in the Palu Bay near Donggala (Celebes). The smallest annual amount on record is 530 mm, at Palu, situated at the extremity of the Palu Bay, the highest amount, 6830 mm, has been measured at Kranggan (Central Java) in the mountain saddle W of M. Slamat.

The highest monthly totals are found, where a wet monsoon current is forced up against a mountain slope. In some cases an average of 1000 mm falls in one month, for instance on the N W slope of M. Tjereme in West Java (Sadareke 1002 mm in January), and the W. slope of M. Muria in Central Java (Batealit 1001 mm in January). On these mountain sides the highest amounts in 24 hours generally exceed 350 mm, on the W. slope of M. Muria they exceed 400 mm.

Very small quantities of rain fall in the dry season in the S E of the Archipelago. At kupang in Timor 69 mm of rain fall during the 6 consecutive driest months. At kupang rain falls once in 3 years on an average, in August and September. In 1914, an extremely dry year, the monthly rainfall at a few stations on the N. coast of East Java was 5 mm or less during 6 months.

The monsoons cause great differences of rainfall between the wind and lee sides of the mountains. An extreme case is found on M. Idjen in East Java, where in August the mean rainfall at Asembagus (40 m high) and Kajumas (930 m), on the N. side, is 1 and 18 mm respectively, whereas 418 mm falls at Pakudo (660 m) on the S. side.

Though the rain fall is so considerable, the time during which it falls is reatively short, on account of the great intensity. The greatest

amount of rain falls during heat thunderstorms and therefore the rainfall has usually a well-defined diurnal variation, most of the rain falling in the afternoon. Hence even in the rainy season the early morning hours are practically rainless in the more sheltered parts of the interior. At Buitenzorg, in July—September, the probability of rain is nearly 100 times greater between 4 and 8 in the afternoon than between 3 and 10 in the morning.

The highest rainfall intensities during short periods are very much the same in the tropics and in temperate latitudes; for longer intervals, however, the tropical intensities are higher. The principal difference with the temperate latitudes consists in the much greater frequency of heavy showers in the tropics; the percentage of rain, discharged by showers of at least 1 mm per minute during a period of not less than 5 minutes is 10 times as large in India as in Bavaria (Germany).

**Cloudiness and Sunshine, Haziness.** In the SE. part of the Archipelago the mean percentages of sunshine exceed 90 % in the driest months. The sun burns the whole day in the clear or lightly clouded sky, the rivers dry up, the grass withers and the soil cracks. Nature lies asleep for the greater part, the green trees contrasting strangely with the poor vegetation on the desolate fields and along the scorched roads.

In the rainy season, however, and in the other parts where the rains are more equally distributed over the year, the climate is not particularly sunny, though generally speaking the percentage of sunshine is higher than in the summer months of Western Europe. Pontianak in Borneo, for instance, has an annual percentage of 59 % which is about 10 % more than at de Bilt in Holland in June and July. Batavia has 50 % in the rainy months of December and January.

A characteristic feature of the tropics is the well-marked diurnal variation of the cumulus clouds. They usually begin to form at about 9 o'clock and grow denser and darker, till in the afternoon condensation sets in or till the clouds gradually dissolve in the evening or in the afternoon.

The clearing up of the sky is a common occurrence in the afternoon in coast places. In the interior, and particularly in the mountains, the percentage of sunshine decreases gradually during the afternoon, thus rendering this part of the day rather dull and chilly. In contrast, however, to the afternoon, the mornings in these regions are generally bright; the early morning hours are extremely pleasant in the mountains, hardly any wind is felt, so that one can fully enjoy the bracing influence of the cool air, the heat of the morning sun being sufficient to remove any disagreable sensation of cold.

The degree of cloudiness increases with the height above sea level. The following annual means of sunshine percentage at some stations in West Java may serve as an example.

Batavia (8 m high) 68 %, Buitenzorg (240 m) 63 %, Tjipetir (570 m) 52 %, Pasirsarongge (1200 m) 49 %, Tjibodas (1400 m) 43 %, Mount Pangerango (3020 m) 41 %. In the dry season, however, the summit of Mount Pangerango reaches above the zone of maximum cloudiness, the percentages for the months July—September being 79, 76, 63, 61, 57 and 61 % respectively.

The intensity of the tropical sunshine has often been overestimated. In reality it is scarcely higher at noon than in the temperate latitudes in the midsummer, and with the same height of the sun it is even less high at Batavia than at Washington, on account of the greater amount of moisture in the tropics. The intensity increases with the height above sealevel, being about 30 % higher on the summit of M. Semeru (3670 m) than at Batavia. Notwithstanding its increase with height the intensity of the light can be borne much better in the mountains than in the plains, because it is combined with a lower air temperature.

There exists a typical difference between the wet and the dry season, with regard to the transparency of the air. In the rainy season the air is transparent and the contours of the mountains are sharply outlined in the clear morning sky. This is most obvious towards the end of the wet season, when the cloudiness begins to decrease. In the dry season, however, the sky loses its clear blue colour and assumes a hazy white tint, the outlines of the mountains becoming indistinct. Therefore, a man who wants to see Java at its best and is not afraid of some rain, should see it in the west monsoon, or better still, in the months following it (March—May), before the really dry season, when the transparent air shows the colour effects of the luxuriant landscape to their best advantage.

**Thunderstorms.** Thunderstorms are generally of frequent occurrence in the Archipelago, particularly on the slopes of the high mountains. The seasons, most favourable to their formation, are the monsoon changes, when the air is calm and relatively warm and the vertical air currents rise to great altitudes.

By far the greater part of the thunderstorms are heat thunderstorms. They are, consequently, relatively short-lived and of relatively small extension.

Near the foot of the high volcanoes where nearly every afternoon high clouds are formed on the mountain sides, thunder is heard almost every day. At Buitenzorg, for instance, thunder is heard on 322 days

of the year, in the rainy season daily, and even on most days in the dry season. It is heard between 5 and 6 in the afternoon on 250 days a year, but never from 3—8 a.m. The number of days with thunder is less high at Batavia, but yet 6 times as high as in Holland, the numbers being 133 for Batavia and 22 for De Bilt (Holland).

Fortunately the danger of being struck by lightning seems to be relatively small in the tropics. Though the cases of damage by lightning are not at all rare, yet the effect of the lightning discharges is generally not so serious as in the temperate latitudes. The following case may be mentioned as an example. Every year some Kanari trees, bordering the famous avenue in the botanical gardens at Buitenzorg, are struck by lightning. This becomes apparent by the fact that the leaves of some of the branches wither and fall off; however, neither the trees nor the branches die. In most cases the branches bud anew after a month or longer.

**The climate of Batavia and Bandung.** We shall conclude this paper with some climatological data of Batavia and Bandung. Batavia may be taken as a representative of the warm coast plains, Bandung of the plateaus in the interior at moderate height.

The heat is very uniform at Batavia, the most sultry months being those of the monsoon change in the first part of the year, April and May, which count many a day when complaints about the heat are general. During the remaining part of the year, with the exception of some days in the second monsoon change, those days are rare, and healthy persons bear the heat without discomfort. As a rule, the nights are not so cool that a blanket is necessary, with the exception of the rainy weather in the west monsoon, and the latter part of the night in the driest period of the east monsoon, when radiation lowers the temperature more than normally. The mean monthly values of air temperature and wetbulb temperature in C°., relative humidity and sunshine in %, and rainfall in millimeters are given below.

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Airtemperature | 25.4 | 25.4 | 25.8 | 26.2 | 26.4 | 26.0 | 25.8 | 25.9 | 26.2 | 26.3 | 26.0 | 25.7 | 25.9 |
| Wet bulb .... | 23.9 | 24.0 | 24.2 | 24.5 | 24.4 | 24.0 | 23.5 | 23.3 | 23.5 | 23.8 | 24.0 | 23.9 | 23.9 |
| Rel. humidity | 87 | 88 | 86 | 85 | 84 | 84 | 81 | 79 | 78 | 80 | 83 | 85 | 83 |
| Sunshine ..... | 45 | 47 | 61 | 68 | 69 | 69 | 72 | 74 | 71 | 66 | 57 | 48 | 62 |
| Rainfall ..... | 313 | 322 | 207 | 139 | 107 | 96 | 70 | 42 | 73 | 114 | 146 | 199 | 1828 |

The mean daily maximum of temperature varies from 31.°1 in September and October, and 28.°8 in February, the mean daily minimum

between 23.°3 in April and 22.°1 in August. The corresponding values for the wet-bulb temperature are 26.°5 in April and 25.°3 in August for the maximum, and 22.°9 in April, 21. 4 in August for the minimum.

The great uniformity in the temperature variation from day to day allows of a thorough accommodation to the climate with respect to clothing and mode of living, and it is probably due to this that cases of sunstroke are comparatively rare.

The wind is light as a rule, there are well-defined monsoons and well-developed land and sea breezes. The land breeze is hardly felt at the surface, the sea breeze blows with fairly good vigour, particularly in the last months of the dry season, except only on very cloudy days.

In the months of April—October the rains are concentrated chiefly on the afternoon hours, and are rare in the morning hours. In the west monsoon, however, the fairly frequent rains in the morning not seldom give some trouble to persons going to their offices.

Bandung, lying at 700 metres above the sea, may serve as a representative of the Preanger Uplands, which constitute the fairly level central part of West-Java, the height varying between 500 and 700 metres. By its moderate temperature the climate differs essentially from that of the low plains.

In consequence of the sheltering influence of the surrounding mountains, the rainfall is relatively small on these high plains and they receive a greater amount of sunshine than corresponds with their height. The climate is praised generally; it is cool but not too cold for people who adhere to habits contracted under tropical conditions.

Mean values of air temperature, wet-bulb temperature, relative humidity, sunshine and rainfall at Bandung follow here.

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Airtemperature | 22.0 | 21.9 | 22.0 | 22.3 | 22.3 | 22.0 | 21.9 | 22.0 | 22.4 | 22.5 | 22.3 | 22.1 | 22.1 |
| Wet bulb .... | 20.2 | 20.3 | 20.4 | 20.6 | 20.4 | 19.7 | 19.1 | 18.9 | 19.3 | 19.8 | 20.2 | 20.2 | 19.9 |
| Rel. humidity | 84 | 86 | 85 | 84 | 83 | 81 | 77 | 75 | 75 | 78 | 83 | 84 | 81 |
| Sunshine ..... | 52 | 51 | 55 | 61 | 66 | 70 | 77 | 75 | 70 | 62 | 54 | 50 | 62 |
| Rainfall ..... | 193 | 181 | 243 | 229 | 133 | 92 | 65 | 58 | 91 | 170 | 227 | 216 | 1898 |

The mean daily temperature maximum varies from 28.°7 in October to 26.°1 in January, the mean daily minimum from 19.°2 in January to 16.°7 in July and August.

Though an air temperature of 22° and a wet bulb temperature of 20° is by no means low according to non-tropical standards, the more or less oppressive sensation that is given by the Batavia climate, is

entirely absent at Bandung, at least in the conditions under which Europeans live and work there. At this height above sea level one again begins to enjoy the sunlight instead of shutting it out as much as possible as is done at Batavia. The morning is mostly clear and calm, though fog or low-drifting clouds are by no means rare. In the course of the day the cloudiness increases gradually. During the whole year the probability of rain is much higher in the afternoon than in the morning.

# HYDROGRAPHY

by J. LUYMES,
*Hydrographer of the Navy.*

During the first Dutch expeditions to the East Indian Archipelago undertaken towards the end of the sixteenth century under the brothers HOUTMAN, the maps by PETRUS PLANCIUS and by JAN HUYGEN VAN LINSCHOTEN were used. The former, a minister of religion as well as a acute cartographer, succeeded in publishing in his world map of 1592 the most recent data on the East Indian Archipelago. A single copy of this map survives in the archiepiscopal archives at Valencia; it was chiefly based on the work of the Portuguese geographer BARTOLOMEU LASO. LINSCHOTEN, who as a clerk to the archbishop of Goa had an excellent opportunity of learning what the Portuguese knew of the sea routes to the East, drew chiefly on the maps of VAZ DOURADO. He further gave a mine of information in his celebrated "Reysgeschrift" which was also taken by HOUTMAN's fleet. The United East-India Company, which resulted from the voyages of Houtman, collected during its prolonged monopoly many new data on the hydrographic condition of the seas and coasts of the Archipelago. By 1660 the outline of the coasts of these islands had been pretty well ascertained. It was fairly complete for Java, Sumatra and Borneo but still incomplete for Celebes, inaccurate for the lesser Sunda islands and the Moluccas, and sketchy as regards New-Guinea. The Company, however, kept its collected data a secret as far as possible. It gave its captains valuable, beautifully decorated charts, drawn on parchment, which on their return were brought up to date by adding the latest discoveries. But no large-scale chart ever appeared for sale. It was only in the decline of the company's monopoly that the celebrated publisher VAN KEULEN could in 1753 make generally available the then state of knowledge of the geography of the Archipelago, in the sixth volume of the "De nieuwe groote ligtende Zee-Fakkel" (The new great lightning Sea Torch .

With the methods and instruments of that period scarcely anything better could have been produced, but the introduction of the mirror sextant and of chronometers allowed of greater demands. In the beginning of the 19th century it was seen that the charts no longer satisfied modern ideas of accuracy and repuired to be prepared de novo. For this purpose a "Comité tot verbetering van zeekaarten" (Committee for the impro-

vement of charts) was instituted, which, however, only resulted in individual, albeit meritorious, attempts and by no means brought about a purposeful, comprehensive effort on a broad basis. Not until 1858 began the regular permanent hydrographic survey of the Archipelago! From that time onwards Dutch survey ships have been at work without intermission. In 1883 their number was extended to three, in 1906 to four, and this number has been maintained. In the aggregate they have worked for 190 ship-years and as a result about nine tenths of the very extensive coast lines (estimated at 25.000 sea miles) and of the coastal seas of the thousands of islands have been charted in a modern fashion. Assuming a uniform rate of progress, this work will be finished in 1931. The present position of the work is best shown by the annexed sketch map in which the systematically charted seas and coasts are indicated.

The charts of the uncoloured portions are compilations from all known data, collected in course of time by mariners and others. These compilations are based on the several hundreds of astronomical positions, fixed expressly for this object by geographic engineers and naval officers between the years 1851 and 1894.

The whole Archipelago is charted on overlapping charts, both on the scale of 1 : 3.000.000 and on that of 1 : 1.000.000. On a scale of 1 : 500.000 the complete charting has not yet been accomplished totally for the most eastern part of the Archipelago but will be so in the near future.

All coasts which have been surveyed systematically, are further represented on charts which scale varies between 1 : 300.000 and 1 : 150.000; mostly 1 : 200.000. These coastal charts also join up with overlapping. Of the few portions not systematically surveyed only a few coastal charts have been published.

There further exist a larger number of charts on a scale of 1 : 125.000 and larger, of the most frequented parts of the Archipelago, of the less easily navigable waters and of various harbours, roadsteads, bays, anchorages, smaller islands etc. The extent of the charting of the Archipelago is best seen from the following table, taken from the catalogue published in 1926, corrected till March 1928.

| Number of charts | Scale | Remarks |
|---|---|---|
| 2 | 1 : 3.000.000 | Easter and Western sheet |
| 14 | 1 : 1.000.000 | Joining up to one whole |
| 34 | 1 : 500.000 | |
| 112 | 1 : 300.000 to 1 : 150.000 | With 833 detailed charts |
| 182 | 1 : 125.000 and larger | and plans |
| Total number 344 | | |

By far the greater part of those charts are executed in copper and printed directly from the copper plates.

The regular publication "Berichten aan Zeevarenden" (Notices to Mariners) gives an opportunity of keeping charts in use up to date. Further information of importance to shipping is collected in a "Zeemansgids voor den O.I. Archipel" (Pilot for the East Indian Archipelago) in six volumes and in a list of lights. For the origin of the data given in this work on the domains of meteorology and tides we refer to the chapter on "Oceanography" in the present series. We may add that for eight important harbours with rather shallow access yearly tide tables are published giving the minimum depth which may be expected from hour to hour in the fairway. Furthermore that the surveying ships observe tide-gauges during the survey and that on board of them harmonic constants are calculated by which the chart datum [1]) is fixed. For more than 240 places those constants are now known.

When the first systematic survey will be completed, no time will be lost to begin revising surveys from 70 to 40 years old, to deepen and to extend those made formerly in less favourable conditions and to applicate modern methods which have been invented in course of time, such as scouting by aeroplane, dragwork and echo sounding; in the first place to get certainty of knowing all existing dangers to navigation in those seas, which are infested by reefs. Those modern methods are already in accidental use but not framed in a systematic organisation. Reefs have been found by dragging and by scouting from the air and, especially to the South of Java numerous echo soundings have been made to explore the there existing interesting deeps.

[1]) By chart datum is meant the plane to which all depths in the chart are reduced.

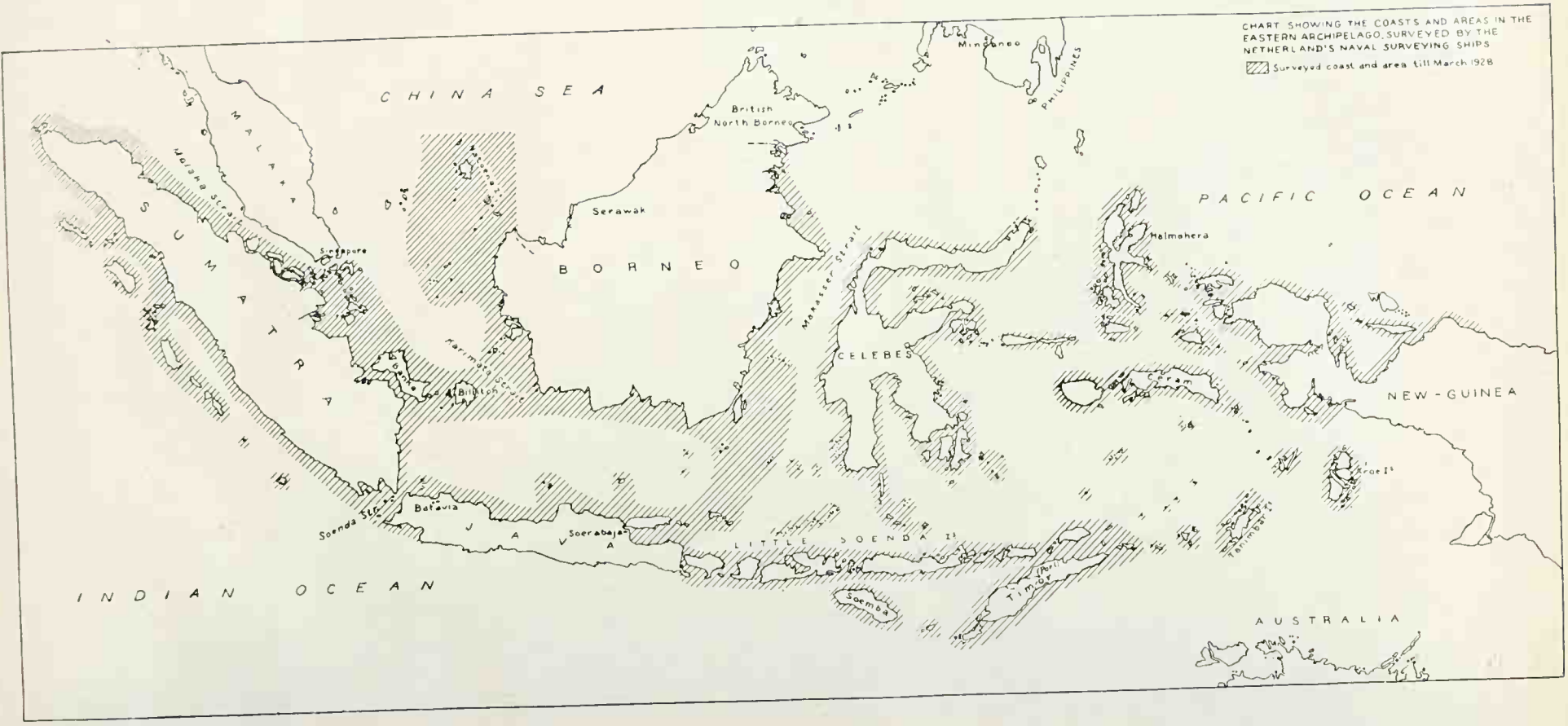


CHART SHOWING THE COASTS AND AREAS IN THE EASTERN ARCHIPELAGO, SURVEYED BY THE NETHERLAND'S NAVAL SURVEYING SHIPS
Surveyed coast and area till March 1928
CHINA SEA
MALACCA
Malacca Strait
SUMATRA
Singapore
Serawak
BORNEO
British North Borneo
Mindanao
PHILIPPINES
PACIFIC OCEAN
Halmahera
Makassar Strait
CELEBES
Banka
Billiton
Karimata Strait
Ceram
NEW-GUINEA
Aroe Is
Sunda Str.
Batavia
JAVA
Soerabaja
LITTLE SOENDA Is
Timor
Soemba
INDIAN OCEAN
AUSTRALIA

# OCEANOGRAPHY AND MARITIME METEOROLOGY

by Dr. E. VAN EVERDINGEN.

*Director of the Royal Meteorological Institute at De Bilt (Holland) and professor of Meteorology, University of Utrecht.*

1. **Maritime meteorology.** The East-Indian archipelago, situated between the Indian and the Pacific Oceans, both offering interesting problems to navigators on the big ocean-routes, is for the greater part so near the equator that from the seaman's point of view as a rule no very noteworthy phenomena are to be observed within its borders. Whereas for both oceans a wealth of information has been obtained from the numerous meteorological logs of the dutch mercantile fleet, collected since BUYS BALLOT's time by the Dutch Meteorological Office at De Bilt, the first atlas [1]) for the East Indian Archipelago, published in 1897 by the "Kon. Magn. en Meteor. Observatorium" at Batavia, contained for this reason only the results compiled from the logbooks of Dutch men of war, during their cruises from 1814—1890. The total number of estimates of wind and observations of weather and condition of the sea dealt with amounts to nearly 525000.

Since then, the various mercantile vessels belonging to the large dutch shipping companies extended their observations more and more to the sea of the archipelago. In the four quarterly atlases of the Indian Ocean [2]) and the annexed tabular volumes, published by the Dutch Institute between 1908 and 1914 in order to replace the sailing directions issued since the first days of its foundation (1854), part of the area within the archipelago could be represented. In the meteorological logs, all observations are expressed in international scales and are made by the aid of instruments furnished and verified for the purpose. As a matter

[1]) J. P. VAN DER STOK. Wind and Weather, Currents, Tides and Tidal Streams in the East Indian Archipelago. Kon. Magn. en Meteor. Observatorium, Batavia, 1897.

[2]) Observations océanographiques et météorologiques dans l'Océan Indien. Tableaux et planches. Kon. Ned. Meteor. Instituut, no. 104. Juin-août 1856—1908, (1924) (new edition completed up to 1923), décembre-février 1856—1910 (new edition completed up to 1923) (1927), mars-mai 1856—1912 (1914), septembre-novembre 1856—1914 (1915).

of principle, all mean values for one degree squares have been tabulated and printed, so as to be available for all practical and scientific purposes.

A contribution to the maritime meteorology of the Pacific was given as early as 1863 for the region from Java to the Chinese sea [1]), and in 1884 a tabular volume followed, giving observations from German and Dutch ships in square 97A (Chinese sea). Compilation of the material available for other parts of the Pacific has been started and will be accelerated as soon as the atlases for the Atlantic Ocean have been completed.

Various special investigations based on the observations mentioned have been published and are enumerated in the bibliography [2]).

The most recent compilation for the archipelago and its immediate neighbourhood has been utilised for a publication by the Kon. Ned. Aard. Genootschap on the seas of the East Indian Archipelago [3]). Results for two degree-squares are given here for the four seasons. The total number of observations of pressure, wind, current and temperature of air and surfacewater amounts to more than 1.100.000. Examples of the illustrations are represented in the figures p. 71. The accuracy of the results is demonstrated by the fact that isobars, drawn by the present writer after some smoothing of the pressure figures without any regard to wind direction, give an almost complete explanation of all particulars of the winddistribution, shown by a map compiled from wind observations only. (Figures p. 55, 56 in dr. BRAAK's paragraph on climate).

Another application of the data compiled in the tabular volumes, completed by new discussions of the original extracts of logs prepared

[1]) Voyages dans le Golfe de Chine et la partie occidentale du Pacifique septentrional et recherche concernant les vents, les courants de mer etc. Atlas, Kon. Ned. Meteor. Instituut No. 29a, 1863, 1876, 1879.

Tabellarisch overzicht der meteorologische waarnemingen van Nederlandsche en Duitsche schepen in de Chineesche zee, Quadraat 97 A. Kon. Ned. Meteor. Instituut. No. 62, 1884.

[2]) Opstellen op Oceanografisch en Maritiem Meteorologisch gebied, Kon. Ned. Meteor. Instituut No. 111 1, 2 1920, 1921.

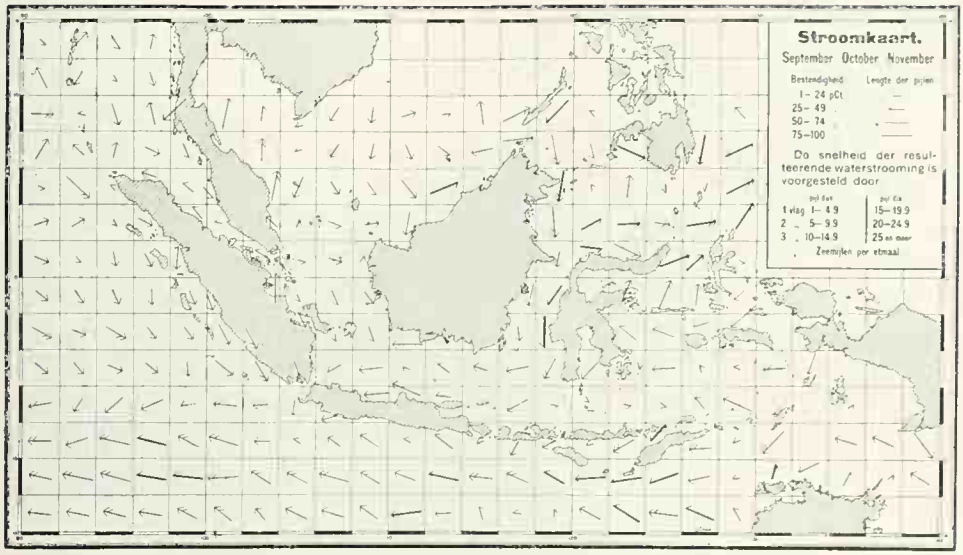
(Papers by P. H. GALLÉ on cyclones in the Chinese sea I p. 49—54, by GALLÉ and VAN WIJCK JURRIAANSE on a typhoon near Hongkong II p. 24—46).

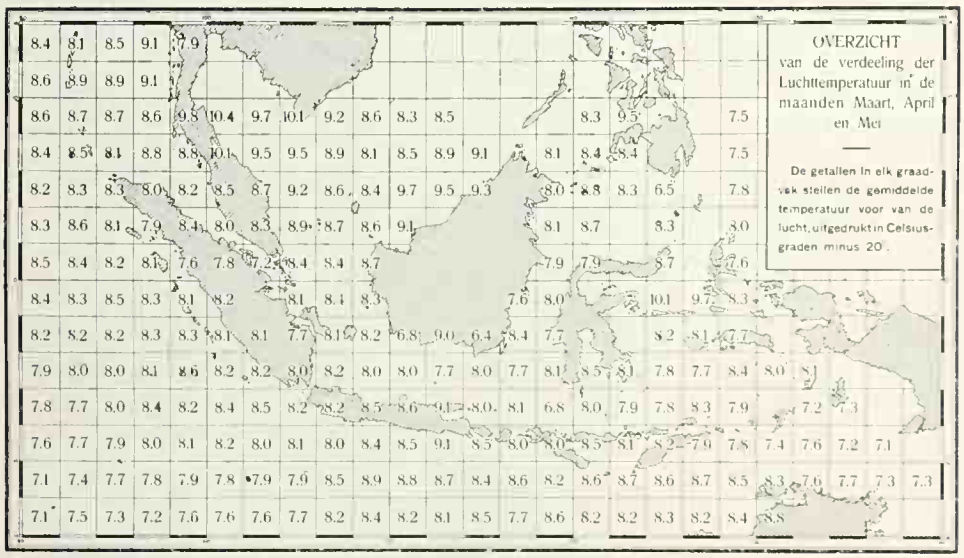
Papers in Dutch in the periodical „De Zee":

P. M. VAN RIEL, a tropical cyclone in the northern Pacific, De Zee 1920 p. 696—699. — A typhoon in the South China sea ib. 1923, p. 88—94. — The Swatov typhoon, ib. 1923 p. 304—401. — The Pacific between 30° and 50° N with some of the principal steamer routes ib. 1925, p. 764—796, 1926, No. 1—18.

H. KEYSER, abnormal typhoon-track in the Western part of the Northern Pacific ib. 1925 p. 191—201.

[3]) De Zeeën van Ned. Oost-Indië (Kon. Ned. Aardr. Genootschap). J. P. VAN DER STOK, Maritieme Meteorologie en Getijden, p. 182—212, Leiden Brill 1922.





OVERZICHT
van de verdeeling der Luchttemperatuur in de maanden Maart, April en Mei
De getallen in elk graadvak stellen de gemiddelde temperatuur voor van de lucht, uitgedrukt in Celsiusgraden minus 20°.

at the office at De Bilt is to be found in P. H. GALLÉ's Climatology of the Indian Ocean [1]), of which 3 chapters: I Atmospheric Pressure, II Wind, III Current have appeared.

2. **Tides.** At the request of the Royal Society of London in 1838, a series of observations of tides was made in the Dutch East Indies in order

[1]) P. H. GALLÉ. Climatology of the Indian Ocean, Kon. Ned. Meteor. Instituut, No. 102. Mededeelingen en Verhandelingen No. 29a 1924.

to elucidate the peculiar and abnormal tides occurring in these seas. No satisfactory explanation of the phenomena could however be deduced from that series at the time. It was not until Sir GEORGE DARWIN had published his theory of the application of harmonic analysis to the tide problem that real success could be expected.

The method of distributing a number of self recording tide gauges could not be applied here on account of the lack of proper sites and trained assistants, and the considerable cost involved. J. P. VAN DER STOK, however, has demonstrated in his studies on Tides in the Indian Archipelago [1]) that simple readings from tide gauges at well chosen hours are quite sufficient to give an insight into the mechanism of the tidal movements, and allow to resolve these in the principal partial tides. In this way the various types, diurnal, mixed and semidiurnal, were fully explained.

Instead of the usual cotidal lines, separate charts of the principal semidiurnal and monodiurnal partial tides were published for the first time in these studies. Practical applications were added by description of the method of tide prediction from the calculated constants. After the first collection of tidal constants given in the atlas referred to above (1), a considerably larger number (140 stations) was collected in a popular treatise on the theory of tides published by the „Kon. Ned. Meteor. Instituut" at De Bilt [2]). Fig. 3 has been taken from this publication.

Since then the Naval Department has published tables [3]) including theoritical explanations and new tidal constants, whilst sa full list of known tidal constants for upwards of 240 stations may be found in the "Zeemansgids voor den O.I. archipel" [4]) issued by the same Department.

The Observatory at Batavia annually publishes very elaborate Tide-Tables containing the calculated tides for the principal harbours and rivers. [5])

3. **Sub-surface research.** Since 1914, in connection with the hydro-biological work of the Fishery station at Batavia (at present called

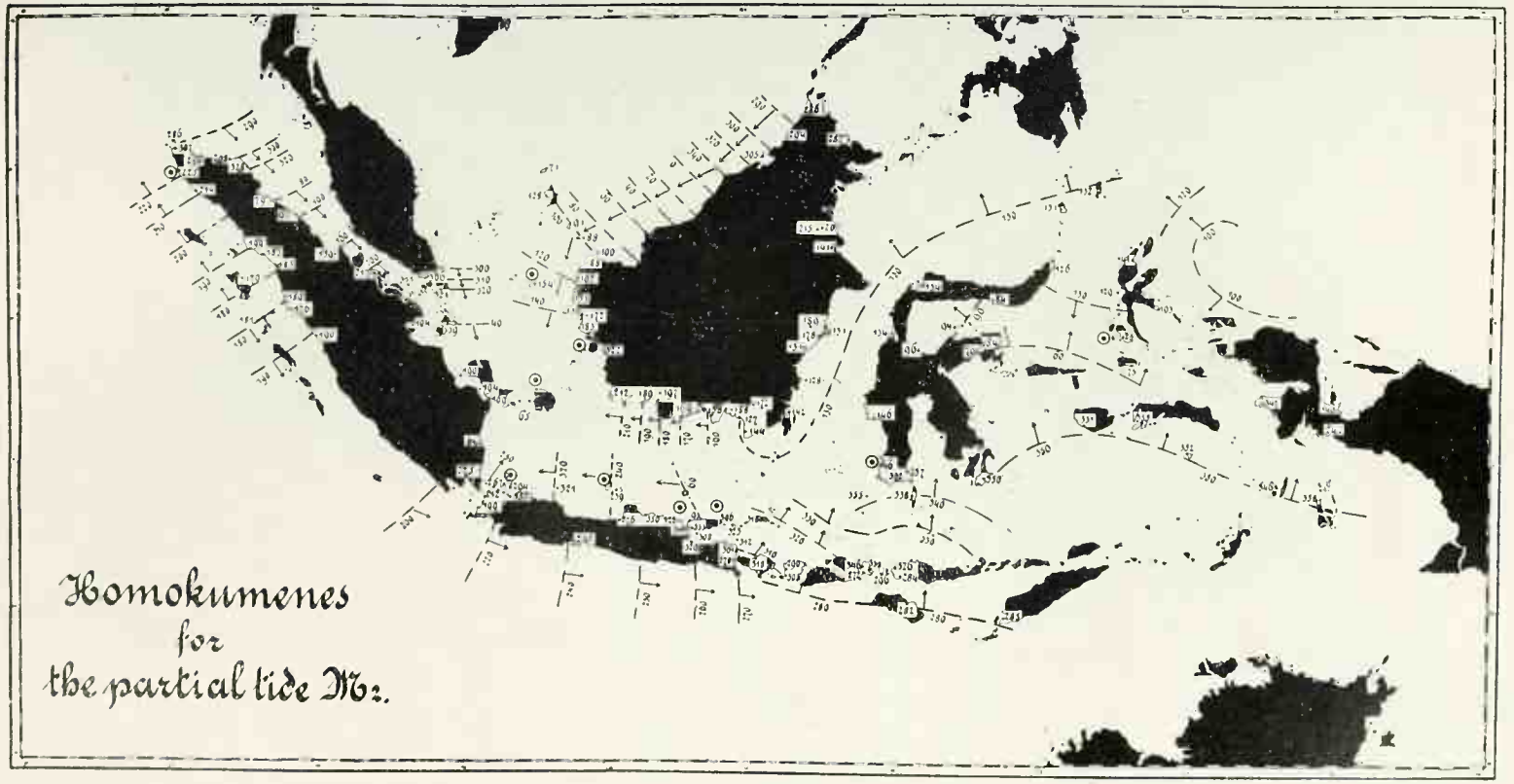
[1]) J. P. VAN DER STOK. Studies over Getijden in den Indischen Archipel I—XIV. Tijdschrift Kon. Instituut voor Ingenieurs Afd. Ned. Indië 1890—1896. XV—XVI Natuurkundig Tijdschrift van Ned. Indië 1896.

[2]) J. P. VAN DER STOK. Elementaire theorie der Getijden. Getijconstanten in den Indischen Archipel. Kon. Ned. Meteor. Instituut No. 102, Mededeelingen en Verhandelingen No. 8 1910.

[3]) A. HAVERKAMP. Zeevaartkundige tafels. Departement van Marine 1918.

[4]) Zeemansgids voor den O.I. Archipel, I—VI (1921—1922).

[5]) Getijtafels voor Deli-geul, Palembang-rivier, Koetei-rivier, Kleine Kapoeas, Westgat Soerabaja, Oostgat Soerabaja, Barito, Tjilatjap, Aroe-baai. Kon. Magn. Meteor. Observatorium, Batavia.



Homokumenes
for
the partial tide M2.

Laboratory for the investigation of the sea) under A. L. J. SUNIER an extensive investigation of temperature and salinity with occasional measurements of currents has been carried out in the shallow waters in the Western half of the Archipelago, especially the Java sea. Between 1914 and 1920 seven cruises were made in the steamer Brak in which Capt. K. H. VAN WEEL or Mr. P. C. VAN KOESVELD collected a very rich material of observations. The results have been published in extenso in "Treubia" Vol. IV, Liv. 1—4 1923 [1]) accompanied by a separate map with charts and vertical sections. A discussion of the work is given by H. P. BERLAGE [2]) in the "Verhandelingen" of the Observatory at Batavia. The relation between wind and current is traced in those cases where both are known with sufficient accuracy; as far as the current is concerned either by direct measurement or from ships observations as summarised in the Sailing Directories of the East Indian Archipelago [5]).

4. **Deep sea investigations.** A considerable number of exploring vessels under various flags has crossed the seas of the Indian Archipelago in the course of time, and in the eastern deep parts the tracks of Dutch exploring vessels and cableships alone from a rather close network. The number of deep sea soundings and observations of temperature and salinity obtained on foreign expeditions however is very small, as these usually only crossed the archipelago on their way from and to the big oceans. On the other hand the Dutch Siboga Expedition (c.f. the Chapter on Zoology) under MAX WEBER was largely devoted to biology. Hence, though the depth of the numerous deep basins is roughly known and the principal features of the distribution of temperature and salinity have been outlined, much has been left to future research, and the data collected will have to be tested by modern accurate methods. We are glad we can add that in 1929 a well equipped Dutch oceanographic and geological expedition will be ready to undertake a thorough investigation of this remarkable region. The expedition prepared under the auspices of the Society for the physical investigation of the Dutch colonies and the Royal Dutch geographical Society has been largely assisted by the colonial Government, the remaining part of the funds being provided by private grants. Leader of the staff will be Lieut. Comm. VAN RIEL, Chief of the Oceanographical Section of the Dutch Meteor. Institute at De Bilt.

[1]) TREUBIA: Receuil de travaux zoölogiques, hydrobiologiques et océanografiques, 's Lands Plantentuin, Batavia 1923.

[2]) H. P. BERLAGE, Monsoon currents in the Java sea and its entrances. Kon. Magn. Meteor. Observatorium Batavia. Verhandelingen No. 19. 1927.

# EARTHQUAKES

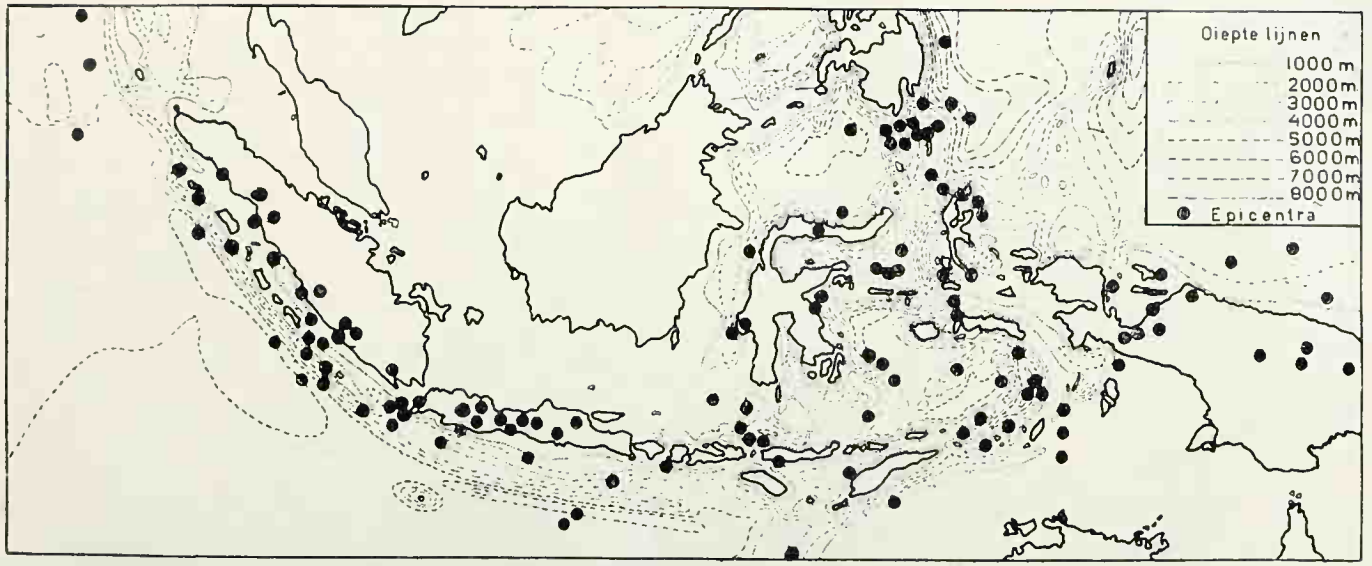
by Dr. C. BRAAK,

*Formerly Director of the Royal Magnetical and Meteorological Observatory at Batavia.*

The Netherlands Indies belong to those parts of the world where seismic disturbances are most frequent. There is a stable region which makes an exception; this includes Borneo, Sumatra east of the Barisan range, the South China sea, the Java sea between Borneo and Java and northern Java. Another stable part of the earth crust is the Sahoel bank bordering the Archipelago at its aestern extremity. In the remaining part, however, earthquakes are a common phenomenon, in particular on the steep submarine slopes.

For a research after the distribution of earthquakes we have at our disposal a great many macroseismic reports which are collected by the Observatory at Batavia. This kind of information, however, is rather misleading, dependent as it is to a great extent on the density and education of the population. We shall leave this source of information entirely out of account because we possess a far more trustworthy one in the publications of the Observatory at Batavia, which deal with the results obtained from records of seismographs. Dr. VISSER, now subdirector of the Observatory, has calculated the epicentres of a great many earth quakes by means of the records of the 1000 kg. seismograph at Batavia and those at the nearest foreign stations, and it is chiefly from his papers that the following particulars have been taken. For the calculation of the epicentres in the neighbourhood of West Java the records of the 100 kg. seismograph of Mr. BOSSCHA at Malabar were of great value. During the last years the determination of the epicentres has been put on a still more solid base by the establishment of a 1000 kg. seismograph at Ambon, in the Moluccas, in October 1924.

A region of high seismicity is found along the west coast of Sumatra. The epicentres are nearly all submarine and most earthquakes emanate from the trough between Sumatra and the isles west of it. Regions where particularly heavy tectonic earthquakes have taken their origin lie to the west of Benkulen (South Sumatra) and in the Indian Ocean in the neighbourhood of Strait Sunda. A great many epicentres lie on the




Distribution of epicentres in the Archipelago according to Dr. Visser.

submarine slopes along the south coast of Java, but the earth quakes from this region are usually not so serious.

The connection between epicentres and submarine slopes is very evident in the Moluccas. The epicentra are situated on the slopes along the coasts of the islands, bordering the Banda sea.

The results of Dr. VISSER about the distribution of the epicentres are given on the subjoined map, in a somewhat simplified form.

We may conclude from the above-mentioned facts that considerable movements are taking place in the crust of the earth, and that in those unstable parts the process of folding under the action of orogenic forces is in full progress.

As far as can be made out, all those submarine earthquakes are of tectonic origin, and not due to volcanic action, as the layman is always too much inclined to suppose.

The relatively small number of earthquakes which have their origin on land, are also chiefly tectonic, only a few very light ones being the result of volcanic activity.

It is very fortunate that most of the epicentra are submarine. Inasmuch as the energy of the shocks decreases generally with the square of the distance, the disturbance has lost a part of its force before reaching the coasts, and farther inland the intensity decreases rapidly. Still, when the earth quake is a very serious one, the coast places may become the scene of fairly great damage, which for instance occurred at Benkulen.

Though the number of earthquakes originating on land is small and their intensity is not very great as a rule, in comparison with the strong submarine earthquakes, yet they constitute a factor of danger which is by no means negligible. On the contrary, those land quakes are responsible for a good deal of the destruction caused by seismic action. They are mostly of a local character, but often have a destructive force in the vicinity of their epicentre.

A well-defined area of these earthquakes in found in Sumatra. From Lake Toba in the north as far as Strait Sunda in the south a series of longitudinal fault lines runs between the mountain ranges of the Barisan, which in the course of time has been the scene of local destructive shocks, causing damage to buildings and leading to land slides. The most recent of these was the earth quake of 28th June 1926 in the Padang Uplands. Besides much damage to buildings and other structures, great parts of the beach of Lake Singkarak sank away, and depths of 10 metres were found in several places, where the land was dry before. Moreover high tidal waves were formed in the lake.

An other recent seismic disturbance along the same vault line was the violent earthquake on April 1, 1921, in the Uplands of Tapanuli

near Lake Toba. The macroseismic area had a radius of 440 kilometres.

Serious damage was inflicted in a narrow region with a length of 80 km., extending along Lake Toba and farther to the south to Tarutung in the valley of the Batang Toru. The area of greatest destruction extended along the coasts of the south western basin of Lake Toba. Tidal waves were observed in the lake, and parts of the coastal areas sank into the water.

There have also occurred some earthquakes which have their epicentres in Java, but their distribution is not so regular as in Sumatra. A disastrous earthquake occurred on January 14, 1900, along a line of fracture from Karangtengah to Tjibeber, in West-Java serious, damage being done in the town of Sukabumi. At Maos strong shocks were felt on September 9 and 10, 1916, and also on May 15, 1923. In both cases the disturbance took its origin from the fracture in the earths crust, where the river Seraju breaks through the mountains. Considerable damage to buildings and land slides on a large scale were the result of the earthquake which took place near Wonosobo in the upper part of the basin of the river Seraju, on November 12, 1924.

We see therefore that the earthquakes with epicentres on land are not infrequent in Sumatra and Java; by far the greater part however of the earthquakes felt in these regions have a submarine origin. Among 859 earth quakes felt in Java, during the period 1909—1921, only 13 had an epicentre which was not submarine, in Sumatra the records mention 748 earth quakes in the same period, 6 of which had their origin within the coastline.

Whereas the land quakes of Sumatra and Java are characteristic of the southwestern and southern border of the large stable aseismic region of the western part of the Archipelago, the eastern border of the stable region is formed by the east coast of Borneo, where some local earthquakes have been observed having epicentres on land, not far from the coast line.

Beyond the unstable region of Celebes, the Minor Sunda Isles and the Moluccas, where considerable displacements in the earth crust are still going on, and where submarine epicentres are the rule, we find in New-Guinea a large land area where not only epicentres on land are fairly frequent, but where many earthquakes have originated of a very serious character, competing in intensity with the most terrible shocks of submarine origin. They indicate that in New-Guinea, which is covered by the highest mountain ranges of the Archipelago, the mountain-building forces are still in full operation.

The most serious earthquake on record, with respect to the damage

caused by it, seems to be that of February 17, 1674, which destroyed the town of Ambon, in the Moluccas.

The principal cities of Java, Batavia, Semarang, Surabaya and Bandung appear to lie on fairly stable ground and their distance from the seismic region in the Indian ocean is large enough to ensure a rather high degree of safety. The most serious earthquake, which has occurred at Batavia, as far as reliable information is available, was that of January 5, 1699. It took its origin from the northern slopes of Mount Gedeh and Mount Salak. Some forty houses collapsed at Batavia, and in the upper course of the river Tjiliwong land slides sent great masses of mud and large trees down the river, which led to disastrous consequences for the town.

Generally speaking we may state, that though a great many shocks are felt in the Archipelago, the earthquake-danger is relatively small. The average number of quakes reported in Java is about 200 a year, for the whole Archipelago it is 460, which is a lower limit, owing to the incompleteness of the information available. Still the damage is not very serious and, moreover, it might be reduced materially, if in the most dangerous regions better earthquake-proof constructions were applied. As a matter of fact a great part of the damage done to buildings by recent earthquakes was the result of the poor material used for the brick buildings.

# VOLCANIC SCIENCE IN PAST AND PRESENT

by Dr. N. WING EASTON,
*Formerly of the Mining Department in the N. E. I.*

## CHAPTER I.

### HISTORY.

Historically speaking, the study of the East-Indian volcanoes may conveniently be divided into six periods.

§ 1. The **first period,** from time immemorial to the beginning of the 16th century, is the period of indigenous tradition. The Javanese tales concerning volcanoes and their eruptions have recently been compiled by D. VAN HINLOOPEN LABBERTON but, though sometimes containing a germ of truth, these tales are of small scientific value.

§ 2. The **second period** (1500—1800) is that of the interested laymen. Some journals of the great navigators contain descriptions of mountains they saw "burning" during their cruises. Some officials, too, had an opportunity of noting down any information they could get with respect to volcanic outbursts; the Rev. VALENTYN and the naturalist RUMPHIUS rank among the best. Their records concerning the events in the eastern parts of the archipelago are indicative of the fact that in those remote times the Dutch settlements were centralized in the Moluccas. Of Java and Sumatra only scant information is available.

§ 3. The **third period,** from about 1800 till 1875, may be called the dawn of serious volcanic research. It began in the time of the English occupation, during which period the Governor-General RAFFLES stimulated the study of science and went into it himself. After the establishment of the Dutch Government a Committee for Natural Research (Natuurkundige Commissie) was inaugurated in 1820, and though the members were chiefly biologists, yet some of them happened to take a special interest in volcanoes (REINWARDT; S. MÜLLER). By this time there was also a growing desire to ascend these mountains partly for the sake of sport, partly for the love of nature, and as a rule such an enterprise was deemed of sufficient importance to be published. We owe our first, though often rather incomplete knowledge

of many volcanoes to this work of outsiders. For the first time records of some Sumatran volcanoes are mentioned in the papers. In the Official Newspaper (since 1828) and in the *Natuurkundig Tijdschrift* (the leading periodical for scientific research) all information regarding volcanoes was inserted that could be obtained and (since 1850) annual statistics have been published in this periodical.

The only man, however, who, though a botanist by profession, devoted the greater part of his Indian career to the study of geology and especially to the causes and effects of volcanic activity, was F. W. JUNGHUHN. No love of sport but pure scientific interest made him ascend all the principal Javanese volcanoes, map out their top regions, observe with keen intellect the alterations brought about by the successive eruptions and give masterly descriptions of his fields of investigation. In short, it made him endeavour to reconstruct the history of every volcano observed by him. Homage was paid to his uncommon merits in the JUNGHUHN Memorial Volume of 1909, on the occasion of the centenary of his birth. Besides, he collected as many facts regarding the great Tambora eruption of 1815 as were available at the time, so that we can now form a fairly complete notion of this most disastrous phenomenon.

Other scientific workers, though less eminent than their famous contemporary, were STÖHR and ZOLLINGER. The former did valuable work in Java, the latter in some of the Lesser Sunda Islands.

§ 4. In 1850 the Mining Service was instituted, to the competence of which belonged (and still belong) all geologic affairs; and, a quarter of a century afterwards, JUNGHUHN found a worthy successor in R. D. M. VERBEEK, who was the prominent man of the **fourth period** (1875—1900). In the beginning of this period he became acquainted with some of the almost unknown volcanoes in the Uplands of Padang in Sumatra and began to study them. Making use of the latest improvement, he also introduced the microscope into the Indian volcanology. At his instigation the many vast and minor lakes characterising the landscape and considered by him (and for the greater part rightly) to be crater lakes, were carefully sounded and mapped.

The mysterious charm of the volcanoes did not fail to produce its effect on VERBEEK. During the rest of his career he never missed an opportunity to visit them, as is evidenced by his beautiful report on the Moluccas. With his broad view and vast knowledge, his keen insight, his perseverance and indefatigability he was the very man to promote our science. His name became world-famous by his splendid description of the Krakatau eruption (1883). Moreover, in collaboration with FENNEMA, he succeeded in studying most of the other volcanoes

in Sumatra and in revising and completing JUNGHUHN's work in Java.

He was not in a position to visit the volcanic mountains in the Lesser Sunda Islands and in the northeastern part of Celebes. Here WICHMANN and KOORDERS did some valuable work.

VERBEEK and FENNEMA were well aware of the desirability of a closer and more constant observation of the active volcanoes. Yet the former's personal influence, however great, could not induce the authorities to abolish the custom to have those volcanoes visited only after a serious eruption had taken place, with a view to report on the situation for the time being and the prospects of the near future and, this work being done, to abandon the mountain to its fate. They little cared for the alterations brought about between two consecutive eruptions, so that no insight into volcanic action could be acquired.

§ 5. This unsatisfactory state of affairs was only *partly* improved during the **fifth period** (1900—1919). Fortunately, however, a more general interest in volcanology awoke, even in quarters that hitherto had kept aloof from this branch of science. VERBEEK had only exceptionally mapped the crater regions himself; in most cases he made use of the existing topographic sheets which, as may be easily understood, are much less accurate with respect to the uninhabited upper halves of the volcanoes than to their cultivated lower levels. In the first years of the present century, however, the mapping on a large scale of several volcano tops was undertaken by order of Colonel J. J. K. ENTHOVEN, at that time Chief of the Military Topographic Survey, and his successors continued his work. The outcome of this valuable effort, the maps of about fifty craters and their surroundings, was published in the Annuals of the said Survey. Short explanatory texts and many instructive sections and photos are added to these maps.

Among the members of the Mining Staff and others there was a growing consciousness of the importance of sound volcanic research. To this propitious change we owe some interesting papers on volcanoes which, though not altogether unknown, had never before been visited and examined by geologists, e.g. Roeang[1]), Sopoetan, Tolo, Tambora, Rindjani, Batoer, Oena Oena. The vast highland of Idjen was the subject of an elaborate and profusely illustrated monograph by KEMMERLING. It need hardly be said that the more important volcanic phenomena, the eruptions of Kloed, Tangkoeban Prahoe, Sopoetan and Roeang, and the disaster of Loemadjang, which town was devastated by a

[1]) In this chapter the names of the volcanoes are written in Dutch orthography in order to let them agree with those on the map; here some rules are given for correct pronunciation.

large mud flow, caused by a rain lahar (§ 19) from the Smeroe volcano, were minutely described.

It follows that in the period under consideration our knowledge of the Indian volcanoes and especially of the active ones, greatly increased. Without any reserve it can be stated that, with a few exceptions (North Sumatra, the isle of Flores) the properties of all were fairly well known at the end of the period. The interest shown in volcanologic questions extended also to the recent alterations in the depth of the sea around Krakatau; a new bathymetric chart was made in 1919 by order of the Navy Department.

It cannot, however, be denied that the said increase was chiefly about the *morphology* of the volcanoes: only exceptionally had a serious attempt been made to penetrate into the secrets of volcanic life. Or, to put it differently, the investigators had paid much more attention to physiognomical than to physiological study. In order to make the vast amount of profitable work done a matter of general benefit and a blessing to the population, it was an imperative necessity to consider not only the *exterior* of the volcanoes, but to do the utmost to solve the many puzzles as regards their *interior*, in order to obtain an exact appreciation of the visible features. Indeed, the problem was difficult and its solution was sure to take a long time, but it was also interesting and worth while.

§ 6. A lecture delivered by the present writer in October 1915 on this deficiency of our knowledge and the means to remedy it, happened to attract the attention of the Minister for Colonial Affairs. The result was the institution, by the Physical Society (Natuurkundige Vereeniging) at Batavia, of a Volcanologic Committee to co-operate with the Mining Staff for the double purpose of taking up the general scientific study of the Indian volcanoes and particularly the watching of the more dangerous.

This Committee has been active only a short time. Immediately after its institution in 1918, Dr. G. L. L. KEMMERLING was sent to Sumatra to study some volcanoes, especially Sorik Merapi, about which mountain alarming rumours had been received. This journey had hardly been completed, when an unforeseen and most disastrous event startled the Indian community. On May 20th, 1919, the contents of the Kloed crater lake, estimated at about fourty millions of cubic metres of water, were suddenly thrown out over the wall, mainly on the southwestern slopes and, absorbing on its way the large amount of loose material accumulated in the course of many years, formed a tremendous flow of mud and rock which, moving with great velocity, reached the surrounding plains after a very short time, devastating

the town of Blitar and several villages, at the same time causing the death of 5500 people. Its result was a repetition of the Loemadjang disaster spoken of before, but on a still larger scale, though its cause was different. This was decisive for the action of the Mining Service, which now took the matter into its own hand and instituted an official Volcanological Watching Service (Vulkaanbewakingsdienst) or *Volcanologic Survey* (V.S.), with KEMMERLING as its first chief. Following the example of the Imperial Investigation Committee in Japan, scientific methods of observation were applied for the first time, this being the characteristic feature of the **sixth period,** though it was some time before those methods were more generally introduced.

Some volcanoes situated in the more populated regions were known to be very dangerous, and it was planned at the outset to observe these specially by visiting them periodically during shorter or longer periods. Gradually, however, it became evident that, though this method could without objection be applied to some mountains showing rather slight variations in activity, a more constant watching of other volcanoes could not be dispensed with. As a better appreciation of the different manifestations of volcanism was acquired, the number and kinds of the instruments used increased; further purchases would have been made if ampler means had been put at the disposal of the Survey. For this same reason the constant watching is as yet confined to a set of Javanese volcanoes only. As far as the means allowed and local circumstances made it necessary or desirable, self-registering instruments were mounted (water-gauges, pyrometers, seismographs). Besides, the camera has frequently been used and has proved a most welcome auxiliary to fix the condition for the time being of a top region in its entirety as viewed from an aeroplane. It is TAVERNE'S merit to have introduced this most modern expedient into Indian volcanology.

The V.S. has done splendid work during the short time of its existence. The efficacy of its methods cannot be doubted and its members have not shrunk from observing the volcanic phenomena quite near the spots where they exhibited their principal features, often with real danger of life. This is substantiated by the contents of the copiously illustrated publications, which contain a wealth of valuable information and experience nowhere to be got. Therefore it would have been of greater benefit to our science if they had been written in a language more widely spoken than Dutch [1]) but it is a propitious

[1]) This paper had already been written when the author was pleasantly surprised on receiving the first number of the monthly "Bulletin of the Netherlands East-Indian Volcanological Survey", by which publication a part at least of his wishes has been complied with.

circumstance that the next Congress of the Pacific Science Association will offer its delegates a rare opportunity of partially escaping this difficulty and of ascertaining with their own eyes what has already been achieved.

The publications mentioned are of two kinds. First, the *Vulkanologische Berichten* (Volcanologic News), inserted in the *Natuurkundig Tijdschrift*, abridged compilations of the records collected by the V.S. and published in expectation of the more extensive papers to be mentioned hereafter. Fifty-two numbers of these "Berichten" have been issued.[1]) — Secondly, the *Vulkanologische Mededeelingen* (Volcanologic Intelligence), bearing the character of monographs and published by the Government, seven of which papers have been printed. The first five have been composed by KEMMERLING (1920—1923), one by his successor TAVERNE and one by TAVERNE and VAN ES. A new monograph by KEMMERLING on the Flores volcanoes, of which little was known, will probably be published before the meeting of the Congress. In expectation of this monograph a summary was recently inserted (in French) in the *Bulletin Volcanologique*, 1927, Nos. 11, 12. Not improbably papers by CH. E. STEHN on the Batoer eruption of 1926 and on the Krakatau eruption of 1928 will also have been carried through the press by that time.

## CHAPTER II.

### PARTICULARS AND RESULTS OF SURVEYING.

§ 7. At this moment it would be premature to expect a definite answer as to which features are conclusive for the prediction of an eruption and which are of little or no importance. But even in the short space of time that was available to gain experience, our knowledge regarding the signification of those features has greatly increased, though, unfortunately, sufficient progress has not yet been made to judge of their comparative value in the case of an approaching outburst. One of the most important conclusions, however, that experience has taught, is that *only permanent watching with the use of instruments, and daily observation of a considerable number of active volcanoes may lead to success.* The truth of this statement will be evident from what follows.

For the present only four volcanoes of different nature, viz. Papandajan, Kawah Kamodjang, Kloed and Tangkoeban Prahoe are

[1]) These "Berichten" are discontinued and replaced by the Bulletin mentioned in [1]) on p. 84.

being *permanently* controlled, and, since January 1928, also Krakatau; to four others, viz. Merapi, Smeroe, Kawah Idjen and Lamongan the control is either not applied to its full extent or applied at short-spaced periods, but is not permanent. All these volcanoes belong to the most active in Java (except K. Kamodjang) and their situation in the midst of well-populated regions justifies a close attention. There are, however, others, outside Java, not less interesting and above all not less dangerous (e.g. Ija in Flores, Roeang and Awoe in Sangi), which deserve the same attention and yet they can only be visited at rather long intervals for want of a sufficient number of staff members. *This evil ought to be remedied as soon as possible.*

§ 8. The limited space accorded to this article renders it impossible to dwell upon the contents of the publications referred to; it may, however, be of use to resume briefly the principal results in combination with the data contained in some other papers and official documents, in order to point out the present position of our science in this country.

The survey is partly of a morphological and structural kind; this subject will be treated in § 15 ff.

Another part concerns the study of the features which are indirectly connected with the magma, i.e. *the character of the emanated gases and vapours as far as they become visible or perceptible.* The observations belonging to this study can readily be grouped under some headings.

They are I. *physical* (**a.** thermical); registering the temperature of *a.* gases and vapours, *b.* thermal springs, *c.* the sub-soil, *d.* crater lakes and water-filled vents or "Maare", *e.* rivulets and sources. (**b.** geo-physical); controlling variations in terrestrial magnetism and in electric potential caused by shifting of mass in the body of volcanoes, — II. *chemical*; the carrying-out of periodical analyses of *a.* gases, *b.* water from thermal springs, *c.* water from crater lakes and „Maare", *d.* the products of sublimation. — III. *seismical.* — IV. *hydraulical*; controlling *a.* the depths of crater lakes and "Maare", *b.* the movements at their surfaces, *c.* the discharge of springs and vapour vents. — V. *meteorological*; registering *a.* rainfall, *b.* evaporation, *c.* direction of wind, *d.* cloudiness, *e.* humidity, *f.* pressure and temperature of the air. — Hygrometric observations and instruments for the registration of sounds might be of great use.

From these observations the following conclusions may be drawn.

§ 9. **Emanations.** They may or may not be visibly connected with magma in action. In the first case their *temperature* is high. In the second case it is mostly much lower; that of the fumaroles rarely

exceeds the local boiling point of water; that of the solfataras is often somewhat higher; the properties of the former largely depend upon the season. When on a volcano a group of emanations has a high temperature and yet no moving magma is to be seen in the neighbourhood, it may be considered as certain that the magma is perhaps at rest, but is not far off; consequently such spots are suspicious and must be carefully watched (Papandajan). As a rule such a group lies over a former conduit, and it is important to note that emanations lying outside the boundary of the group, even at a short distance, already possess a considerably lower temperature.

Of all emanations it can be stated that the temperature is liable to fluctuations; the wave-length (time factor) in the diagram is often short, the amplitude, on the other hand, may be rather great. Besides, the character of the emanations, even of those belonging to the same group, is not at all the same in this respect. It is therefore absolutely necessary to provide each outlet with a numbered picket and to observe it several times a day, unless self-registering instruments are used. Experience has taught that comparatively great fluctuations (some of 40—50° C. have been recorded) *provided they are local*, need not give rise to uneasiness. It has appeared, however, that if a *group* of high-temperature emanations is *continuously* growing hotter, this feature doubtless indicates an *increase* of the magmatic activity, while almost immediately after the *decrease* of this activity the temperature falls rapidly again, even when the magma remains visibly near (Merapi). Evidently such emanations must be held under permanent control, preferably automatic.

§ 10. The *quantity* of gases and vapours issued at the same outlet varies almost as much as their temperature and seems to be exclusively dependent on the internal pressure (and the rainfall) but, at any rate, independent of the atmospheric pressure. The *composition* of such an emanation is not constant either, especially as regards the inter-relation of the constituents. As gas analyses are attended with many difficulties and experimenting is still going on, no definite conclusion can be drawn for the present. But it has already been demonstrated that neither DEVILLE's nor BRUN's law applies in all instances. *The importance of the composition of gases as a means to predict eruptions will, in future, form one of the principal subjects of investigation*, and a well-equipped laboratory is a necessity that cannot be dispensed with.

Apart from $SO_2$, the dominant magmatic crater gases are $CO_2$ and $H_2S$, and casualties caused by intoxication are usually ascribed to inhalation of the odourless $CO_2$. Spots where accumulations of carbondioxide were known to exist, have therefore been provided

with warning boards. The other gas, though its virulence is much greater, was supposed to be less dangerous, because its bad smell was deemed a sufficient warning in itself. In the course of the last ten years, however, some casualties have occurred in hitherto non-suspected craters, and the analyses made in this period point to the probability that an amount of $H_2S$ sufficient to cause death, but mixed with an adequate quantity of $CO_2$, diffuses rather slowly and is not easily perceptible by its smell. Besides, the presence of other gases of a very virulent character but of unknown composition, is not to be left out of account. *Also for this reason the constant examination and control of the exhalated gases is a matter of necessity.*

§ 11. **Secondary eruptions.** It is somewhat questionable whether a general conclusion may be drawn from the many eruptions on a minor scale, which took place in a section of the Papandajan crater, known as Kawah Baroe, from 1923 to 1925, and in one of the craters of Tangkoeban Prahoe in 1926, which have been carefully studied. It was ascertained that the ejected products consisted of intensely altered *old* material *exclusively*, often in a mudden condition, and were attended with heavy outbursts of hot water and water vapour. It seems probable, when we take into further consideration that the high-temperature group of solfataras in Kawah Mas (Papandajan), at a small distance, showed all the time but rare and insignificant deviations from its ordinary character, that these eruptions are only to be ascribed to the vadose water being converted into steam by the heat transferred from the magma *at rest*, and may be called "secondary" in contradistinction to the "primary" eruptions, in which *moving* magma takes an active part and by which *fresh* material is brought to the surface. The former are nevertheless interesting from a scientific standpoint; moreover, though they are very rarely dangerous to their surroundings, they may, at times, be precursors of an approaching primary eruption. *It follows that a systematic examination of the products thrown out during an eruption, even if this is unimportant, appears imperative.*

§ 12. **Tromometers.** In order to find out the character of the many *seismological* disturbances on volcanoes, tromometers have been mounted at suitable spots on Tangkoeban Prahoe, Papandajan, Merapi, Kloed and Lamongan; it is intended to provide also the Sumatran Merapi with such an instrument. Though the time available for experience was too short to draw conclusions of some importance as regards the significance of the *local* tremors, it was possible to distinguish these from the true *tectonic* tremors. Moreover, the diagrams of the Omori seismograph on the western slope of Merapi clearly indicated the varying activity of the magma. It may be expected, therefore, that the

instruments mentioned will perform one of the leading parts in the prediction of volcanic outbursts.

§ 13. The existence of **crater lakes on active volcanoes** is only compatible with almost impervious floors and walls. The water is generally allowed to rise until the lowest point of the brim is reached, or until more permeable strata outcropping along a part of the wall, drain off all surplus of water (rainfall minus evaporation).

1. The *temperature* of the lake water is influenced by several factors, some of them tending to increase, others to decrease it. In many cases the water temperature near the surface level appeared to be some degrees higher than that of the air owing to the heat transfer from the ebullition of hot gases. The amount of these gases, consequently the amount of heat transferred (their temperature being supposed to remain constant), depends on their pressure with respect to the height of the water column. However, since temperatures and pressures of *visible* emanations are fluctuating, and the *invisible* exhalations at lake bottoms cannot be supposed to break the rule (§ 9), the temperature of the water must vary in proportion.

The dry season with its prevailing sunshine causes a strong evaporation and lowering of the water level; consequently the gases are allowed to escape more freely and the water grows warmer, even if nothing else changes. In the wet season, on the other hand, the comparatively cold rain water mingles with the lake water and cools it; at the same time the water level rises (if possible) and a smaller quantity of gases can escape, causing a diminution of heat transfer if all other circumstances remain unchanged.

It can be imagined that in certain periods several factors co-operate in the same direction, or that their effects have a tendency to neutralize one another; this may account for some abnormal diagrammatic lines observed, and only by assiduous control we may come nearer to a true understanding.

Of course artificial lowering of the water level (Kloed, Idjen) nearly always brings about a strong ebullition of gases and a turbidity of the water.

Properly speaking, a real imperviousness of the crater *floor* is not strictly necessary. The water is then allowed to fill the many cracks in the stop that seals the upper part of the conduit, until an ever varying state of equilibrium is established in this stop between the water pressure from above and the gas pressure from below. The height of the water column is therefore a measure for the pressure of the gases, unless the latter are apt to enter into solution (e.g. acids).

As far as experience goes, there is *no gradual increase* of temperature

with the depth, as could be supposed. Investigations in lake Idjen (1916) showed a uniformity of temperature (33° C.) from the surface level to a depth of 180 metres; from this point downward there was a rapid increase, viz. 35° at 200 metres, 43° at 210 metres, and 83° at 222 metres. In lake Kloed, on the other hand, but a slight difference ($^1/_2$ to 1 degree) was observed from 1923 to 1925 between the temperatures near the surface level and at a depth of 15 metres, the latter (lower!) temperature of from 24 to 26 degrees remaining uniform till the bottom was reached. That this state of affairs, however, is liable to rapid changes, was clearly demonstrated in 1927; the bottom temperature averaged 27° C. on Sept. 1st, 65° on Oct. 7th, 74° on Oct. 19th, and 91° on Oct. 23rd. It is a matter of future examination whether alterations in the rate of acidity of the exhalated gases are connected with the localization of high temperatures near the bottom.

How far the temperature and depth of the lake water and the rate of gas ebullition may serve as indications of an approaching eruption, is still an open question, but from what has been said on this matter it follows that an exact appreciation of the data observed and their combined result ought to be a subject of careful study.

In 1924 a group of six solfataras on the border of lake Idjen was daily observed during a period of three weeks. No relation whatever could be established between their temperature and that of the lake water. This experience, combined with the facts recorded in § 9, justifies the conclusion that the gases are either emitted from different sources of magma, or (what in the author's opinion is more likely) follow passages of different lengths running through media of different characters (compact, porous, tuffaceous, etc.) on their way from the magma to the surface. It may then be expected that these passages will be unequally affected by the magma when it moves to a higher level, and it will be a future problem to make out in each individual case which outlets of gases give the most reliable indications. This problem appears to be very complex and its solution difficult.

§ 14. 11. Allusion has been made to the fact that the **degree of acidity** of the lake waters is not the same everywhere. Probably *all* of them are more or less impregnated with free (sulphuric and hydrochloric) acids. The strongest acidity was found in the bottom levels of the Idjen-lake basin. The springs on the inner sides of the Idjen crater wall also show an *acid* reaction. It is therefore of importance to note that the waters from the thermal springs that are situated at a greater distance from the crater exhibit a feeble *alcaline* reaction, probably due to the existence of alcali silicate produced by the action of the acids on the rocks. The same feature was observed on Sorik Merapi.

Fig. 1. Gli Moetoe, Flores. — Red crater lake (left hand) and greenish-white lake, the latter with solfataras. — After Kemmerling.

Fig. 2. Gli Moetoe, Flores. — The blue-green crater lake. — Courtesy of Dr. Kemmerling. Head of pressure valley on lefthand background.

Fig. 3. Lobetobi Perampoean, Flores. — Recent active plug in old plug crater. — After Kemmerling.

Fig. 4. Recent plug (1918) on Galoenggoeng volcano, Java. — Photo in „Vulkanologische Mededeelingen" No. 6.

In the deeper parts of lake Awoe and that on Sorik Merapi the acidity is obvious but, at the time of observation, it was decidedly less strong than in the case of Idjen. Most remarkable are the three adjacent crater lakes on Gli Moetoe (Flores), all of which contain free acids, but the degree of acidity is very different (Figs. 1 and 2).

On the other hand, the Kloed water was found to be almost neutral, though the active character of this mountain is not in the least inferior to that of the four other volcanoes mentioned.

To give a general idea of the different, but varying, acidities it may be recorded that the water of lake Kloed showed (1923) an acid percentage of .005 N(ormal), that of lake Awoe (1922) of .15 N., that of lake Idjen (1917) of .8 N. and (1923) of 1.3 N. Since all of these volcanoes rank among the active as well as among the very old ones, the conclusion must be drawn that emanation of gases containing free acids is a characteristic feature under the circumstances mentioned. A sudden *and persisting* increase of acidity may be one of the indications of increasing activity.

§15. Proceeding to the *morphological and structural part*, the first place must be allotted to the observation of the behaviour of **lava plugs** (tholoids). Among these, the one in the Merapi crater (Java), which for a long time was supposed to be unique, has of late years been studied minutely and from close by. The eastern part of the present double-plug (Fig. 5) dates from 1883 and was growing until 1909. In this year and at its western border a new plug arose, in which the ever varying activity of the magma has been localized since that time. Close observation has taught that such a plug — the product of slow lava extrusion — does not consist of a heap of loosely coherent slags pushed up by the rising magma, as might be supposed, but of tough molten magma covered by a carapace cracked into coherent blocks and floes. Through a number of vents the inner lava continuously exhalates hot vapours and gases which, combined, make up the visible smoke column of Merapi. An approaching intenser activity is always preceded by an uninterrupted rise of the temperatures in these vents, some of far over 500° C. having been observed under these circumstances (see also § 9).

From time to time the carapace, yielding to increasing inner pressure, bursts and offers a passage to small lava currents. Since the plug bulges over nearly the whole crater wall, and its top level lies 158 metres above the visible part of the wall crest, parts of the plug often happen to snap off and the suddenly congealed but still red-hot lava lumps also descend in the form of avalanches along the steep top slides that are found around the summit (Fig. 6), continuing their course for some

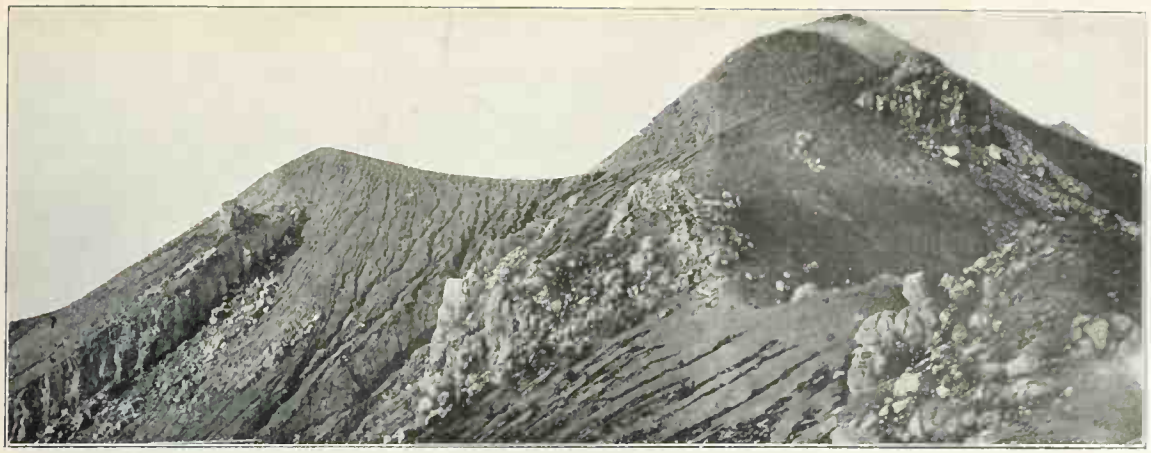


Fig. 5. Double-plug of Merapi, Java, with part of crater wall. — Photo in „Vulkanologische Mededeelingen" No. 3.

Fig. 6. Top slides of Merapi, Java, on double-plug. Air photo after Taverne, Vulkanologische Mededeelingen No. 7.

Fig. 7. Fossil plug on top of Soembing, Java. — Air photo after Taverne, Vulkanologische Mededeelingen No. 7.

length into the existing ravines and river channels (see also § 16).

The plug formation on Merapi was historically known as early as 1786. From the records existing since that year we may deduce that the plug is generally a phenomenon of limited duration and appears ultimately to be thrown out abruptly. At least three different plugs were recorded in the course of last century. The simultaneous presence of *two* complete plugs, such as occur in the Merapi crater, is still unparalleled, in most other respects, however, Amboeromboe (Flores) and Merapi appear to be twins.

In 1904 a plug was seen to rise slowly above the wall of the Roeang crater, Sangi (Figs. 9 and 10). After some lava currents had issued, the movement ceased, and ten years later the plug was blown up by an explosion and has not yet been replaced by another.

Lobetobi Perampoean (Flores) shows identical features as Merapi. After a new crater had been shot out through a previous large plug, a smaller one was pushed up in 1921, which at present occupies about one half of the crater floor and has attained an elevation of 35 metres (Fig. 3). Such perforated plugs have also been observed on other volcanoes.

A rare opportunity to study the coming into being of such a tholoid under the most favourable circumstances presented itself in 1918, when a lava dome rose quietly through the crater lake of Galoenggoeng (Java) to a height of 85 metres; its base, at the close of its growth after one month, covered an elliptic surface of 560 × 440 metres (Fig. 4). A tholoid of similar shape was recently found to exist in the crater of Todoekoe (Halmahera).

The mobility of crater bottoms, which has often been observed, is likewise due to a special case of plug building. Since such a plug differs in many respects from the true tholoids, it may be called a *stop*. A fair example was offered by the Kloed volcano during the period of tunnel construction [1]) after the eruption in 1919. Twice, in December 1920 and in May 1927, an island of scoriae, clearly pertaining to a stop, rose above the lake water, and in the same time the lake bottom rose to a higher average level. Very likely the sudden throwing-out of the lake water (Kloed, Idjen, Awoe) was preceded by the *rapid* rise of the stop, the destruction of which took place immediately after (see § 16).

Of late years a number of *fossil plugs* have been discovered, exhibiting the same structural properties as the recent ones and giving evidence of the fact that the magma at last had lost so much of its

[1]) By means of these tunnels the lake water, with the exception of a small quantity, was drawn off to one of the principal ravines.

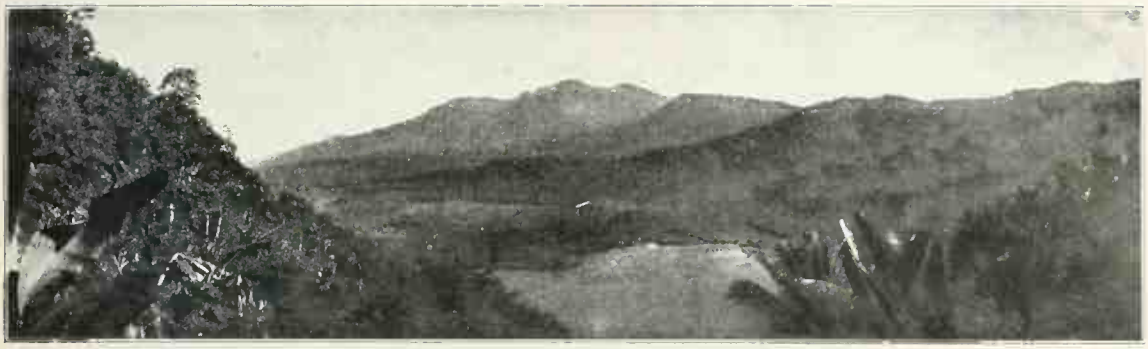


Fig. 8. Outline of Awoe volcano, Sangi Islands. — Photo in „Vulkanologische Mededeelingen" No. 5.

Fig. 9. Photo of Roeang volcano, Sangi Islands, before the plug building in 1904. — After Jaarboek Mijnwezen 1909.

Fig. 10. Photo of Roeang volcano, Sangi Islands, after the plug building in 1904. — After Jaarboek Mijnwezen 1909.

explosive power as to be unable to perform the final act of throwing-out (Fig. 7)..

*It follows that plug building, instead of being a rare feature, appears to be an essential phase in the life of almost every volcano.*

Taking into account that, according to recent investigations, Kloed has already passed through the phase of plug building, while nowadays the less important stop formation takes place, it would appear as though the latter feature represents the fading away of the former. When we take into further consideration that plug formation obviously belongs to one of the maturer stages in volcanic life, the remarkable and unexpected conclusion must be drawn *that an active volcano in its old age is much more dangerous to the surrounding population than in its youth.*

§ 16. The phenomenon of the "**nuées ardentes**" (hot clouds), so well-known of Montagne Pelée in Martinique, could be studied on several occasions. They were always connected with the avalanches originated by the plugs (§ 15). At the moment of contact with the slide surface, the falling blocks of scoriae and red-hot lava lumps with their large amount of involved gaseous substances, are partly crumbled and reduced to powder. While the larger fragments rush father downwards, the dust, mixed up with the liberated gases and vapours, dashes off as a hot emulsion (*nuée ardente*), at first in the same direction as the avalanche, but further on irrespective of ridges and valleys, suffocating all living beings. Merapi was and is still an excellent field of study of this phenomenon, but it was also observed on Roeang and Peuët Sagoë (Sumatra) (see also § 18).

On the occasion of the Kloed eruption in 1919 a *nuée ardente* rushed down the western mountain slope *immediately* after the lake water had been thrown out over the crater wall and a dark smoke column had been seen rising high into the air. Judging from the records, the same phenomenon occurred during the former eruptions of Idjen and Awoe. It is therefore evident that the presence of a lake in the crater of an active volcano does not secure against the calamity of a *nuée*. Probably a small rest of the lake water is suddenly converted into steam with which the fine dust of the explosion is mixed, and this hot emulsion cloud, through lack of initial rising power, simply rolls down the flank in accordance with the laws of gravity.

Whether such *nuées* can also form in the *absence* of water after the final explosive destruction of a stop, is a question that cannot be answered as yet. Taking into consideration that in this case all ejectamenta will be sufficiently cooled before their contact with the surface, the author is inclined to answer in the negative.

§ 17. **Lava emission.** The recent observations on the behaviour of plugs have proved the unsoundness of the general conception that the Indian volcanoes have not produced lava currents in historical times. It was for a long time supposed that only Smeroe was an exception to this rule (end of § 18). Moreover, in each case where the growing up of a new cone in an existing crater could be watched (Raoeng, Sopoetan), emission of lava, even in the initial stages, was observed, sometimes in large quantities. Also in 1905 and 1926 mighty lava currents were seen rushing down the flanks of Batoer, and currents of a somewhat earlier date are still preserved there.

On the other hand we must revise the opinion of VERBEEK, who described several block streams, some tens of kilometres long, and took them for sub-recent lava currents (Slamat, Tjerimai, Raoeng, Idjen etc.). It could, however, be demonstrated that those block streams are the remnants of eruption lahars of an old date (§ 19).

The exact observations made of late years have also revealed the more important part in the structure of strato volcanoes that must be attributed to lava issues, and the author is inclined to surmise that many of these were produced by plugs, which afterwards were blown out and reduced to the agglomerates now seen to alternate with the lava.

§ 18. **Pressure valleys.** A mighty plug filling up the crater space exerts a considerable pressure on the wall, occasionally causing the weakest part of it to give way and rush down. The mass of such an avalanche and its eroding effect upon the mountain flank is so enormous, that broad valleys are hollowed out bordered in their upper parts by steep cliffs, the head of which valleys may be bounded by a precipice (the reader is reminded of the Val del Bove on Etna). Many volcanoes in our country possess one or two of such "pressure valleys" (Fig. 2); formerly their presence was erroneously ascribed to the eroding action of lava currents. The plug losing its support, will, partly at least, follow the original direction of the wall *débris*, and a gigantic *nuée ardente* must then unavoidably form for the same reason as is given in § 16. There is but little doubt that in former times some great calamities were caused in this way (Galoenggoeng, Papandajan). If there is no plug but fluid lava rising in the crater, the course of the phenomenon is about the same, as was proved in 1885 on the occasion of the Smeroe eruption.

§ 19. **Lahars.** An important part of the time of the V.S. was and is devoted to the control of the natural shifting of the volcanic ejectamenta to lower levels. If the rate at which these are carried along is above the average and apt to bring about accidents of different characters, the shifting is designated as "besoek" (on Smeroe), "ladoe"

(on Merapi) or "lahar" (on Kloed). The last name *lahar* is in more general use among our students of volcanology.

Several kinds of lahars must be distinguished. If they are directly related to the magma in movement, they are called *"eruption lahars"*. Water being absent, as in the case of Merapi or in the formation of a pressure valley, they are *dry*. If lake water plays a part, the lahar is called *wet*. In the last case the water is usually thrown out over the crater wall by the rising of the floor (§ 15) and it becomes partly heated to a certain degree — the rate of the heating and the quantity of heated water depending on the height of the water column and the rapidity with which the stop is pushed up — the result is a *hot-wet* (eruption-) lahar. In 1875, on the other hand, part of the Kloed crater wall, 60 metres high, yielded to the water pressure without an eruption taking place, causing what is known as *"the cold* (wet) *lahar"*.

A much more common feature returning almost every year on the flanks of very active volcanoes, is the *rain lahar*, i.e. the sudden shifting of the accumulated *débris* of eruption, erosion and weathering by the rain showers that accompany the wet monsoon and the occasional heavy explosive periods of a volcano. On the exposed flanks of active volcanoes a continuous struggle is going on between erosion and sedimentation, which often causes considerable derangements in the drainage systems, which in their turn constitute a permanent danger to the often densely populated regions encircling the mountain. In co-operation with the Irrigation- and Civil Services look-outs were built on suitable spots from which telephonic warnings can be given; and natural or artificial shelters were prepared to accommodate the people around.

§ 20. Our knowledge concerning **the internal structure** of the volcanoes has made rapid progress; the combined efforts of terrestrial and aero survey have revealed many particulars that were hitherto little known. For want of space this subject, however interesting it may be, can only be treated in a fragmentary manner.

Among our Indian volcanoes two extreme types may be distinguished.

I. Such as dominate the landscape by their height and show the well-known gently-curved outline. Some of these are still more or less active (e.g. Smeroe, Sindoro, Slamat, Inië Rië), others appear really extinct or exhibit only feeble signs of igneous agency (e.g. Merbaboe, Tjerimai, Soembing).

II. Such as are rather low and display an unimposing aspect and an irregular and unvolcanic profile, generally more broad than high (e.g. Kloed, Egon, Awoe, Roeang, Batoer). See Fig. 8.

From what follows it will be evident that a great number of our

volcanoes belong to neither of these types; they are either transitional forms (Papandajan, Raoeng) or they belong to composite forms, in which as a rule the earlier stages have been partly destroyed and covered by the later (Tangkoeban Prahoe), so that it is difficult sometimes to unravel their history.

Though the outward aspect of the volcanoes of type (I) suggests a simple construction, for some of them this is only seemingly so; here the regular outline is interrupted at some distance from the top, indicating that a new lofty cone has been built up in a former spacious crater (Slamat).

The focus of eruption in this type seldom remained the same during the entire building period; in the large majority of cases a shifting of that focus occurred, usually along a fairly straight direction. As long as this shifting took place only over a small distance, the character of the mountain did not change, except for a gradually more pronounced truncation of the top. Not unfrequently, in a certain phase, the magma feeder suddenly shifted to a spot *outside* the body of the volcano, where a new cone, similar to the first, was built up, and such a shifting was here and there repeated several times, usually in the initial direction, so that either twin-volcanoes or a row of volcanoes were formed. Most likely there was a period of rest between the completion of a previous and the initial phase of a later cone. Most (perhaps all) of the volcanoes of this first type are regular *strato*-volcanoes, though recent observations have brought to light that lava currents often took a more prominent part in their construction than was formerly supposed (§ 17). Their acting craters lie on or very near the top; their subsidiary craters are few in number, and they offer *no* hospitality to crater lakes.

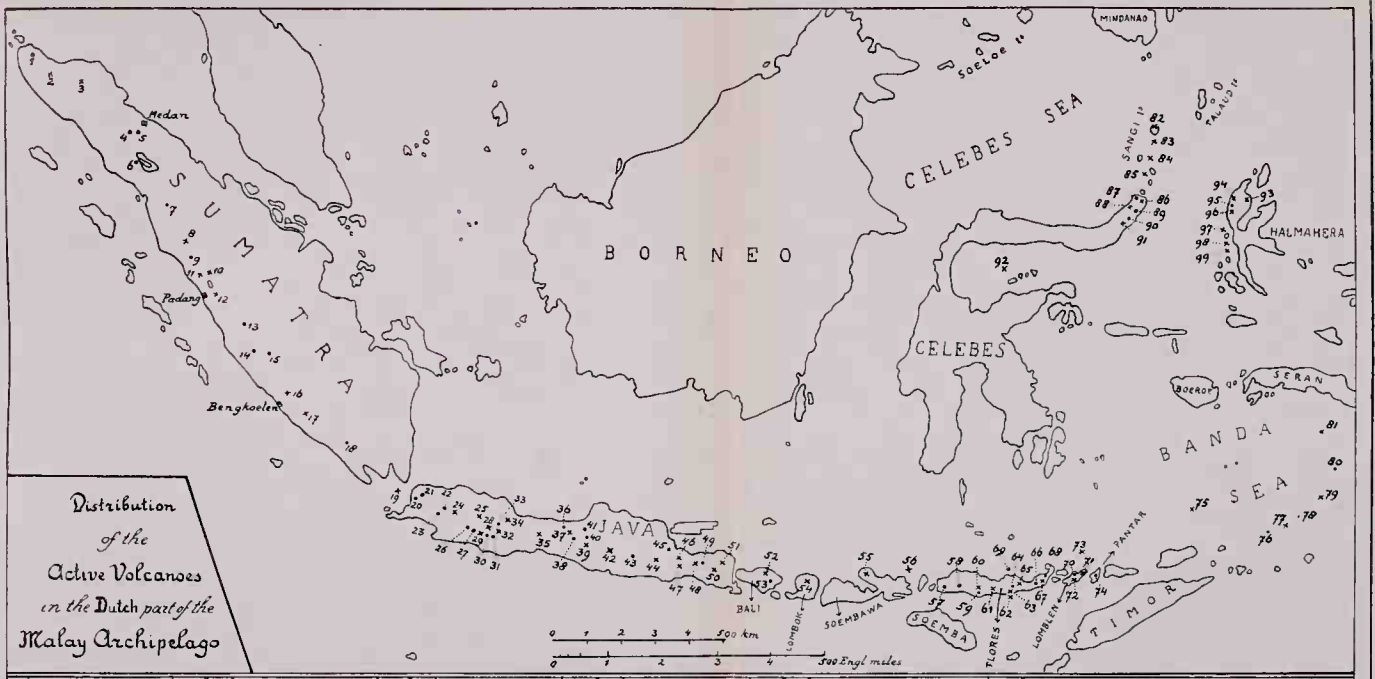
The volcanoes of type (II) are in a maturer stage. With these, too, there was again and again a shifting of the focus of eruption, but it *never* extended to great distances outside the body of the volcano. It follows that the *lower* part of the magma feeder did not change its position, and that *the same mountain* alternately passed through periods of activity and of comparative rest (gas phase; solfataric- and fumarolic stage); the former being characterized by the production of new cones, the latter by strong erosion and the formation of calderas (§ 21). The new cones were built up either more or less centrally, or on or very near the wall. In the latter case a group of such cones, distributed irregularly along this wall, encircles the previous caldera floor, which lost its evenness in consequence of the accumulation of ejectamenta and subsequent erosion, and was changed into a highland (Idjen). In the former case the result was a single mountain of no great height, but of a very complex construction. Moreover, experience has taught

that compact lava in many forms (plugs, currents and larger bodies) plays a prominent part in them. The number of extinct adventitious craters is often large; the situation of the active orifices is usually excentric with respect to the top of the original volcano, and only on volcanoes of this type crater lakes can exist (first sentence of § 13).

§ 21. It is to be regretted that, owing to understaffing and want of time, so little attention has been paid to the **problem of calderas.** The members of our V.S. agree in their conception that these enormous depressions (the axis-length of some of them exceeds 10 kilometres) with their perpendicular walls of from 500 to 1000 metres in height, are the result of subsidences of the top region which contained the craters; indubitable arguments in favour of this conception have repeatedly been put forward. Such a subsidence may have been gradual or catastrophal. Inasmuch as the feature itself must have been preceded by a weakening of the basement, the present writer, as early as 1916, enounced a theory in which the presumptive cause of this weakening was indicated (Cell theory).

Very recently two new theories, based on quite different principles and admitting no subsidences, were published by ESCHER and SANDBERG. The former, starting from the phenomenon that occurred during the Vesuvius eruption in 1906, when an intense stream of gases of comparatively short duration widened the existing vent to a marked degree, supposes that in remote times the intensity of such gas streams may have been so much greater and their duration so much longer as to form gigantic orifices, while subsequent avalanching of the walls enlarged these orifices to the present calderas. The latter even goes a step further and denies the secondary origin of calderas. One of the most characteristic features of a caldera being its high perpendicular wall, his reasoning is that as only one part of a common volcano possesses this property, viz. the vent itself, calderas must simply be such primary vents formed in the earlier days of the latest volcanic cycle, when volcanism was much intenser than nowadays.

It is not the proper place here to discuss the merits of these different theories, but indisputably our archipelago offers a beautiful field of investigation for a detailed study in this direction, which may be recommended to our Volcanologic Survey. Without doubt such a study will contribute in a large measure to our knowledge of volcanic life.




| | SUMATRA | | | JAVA | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Seulawah Agam | | 20 | Poelosári | | 39 | Mêrápi | 1924 | 61 | Amboetomboe | 1855 | | SANGI ISLANDS | | | | | | | | | | |
| 2 | Peuet Sagoee | 1920 | 21 | Karang | | 40 | Mêrbâboe | | 62 | Ija | 1882 | | | | | | | | | | | | |
| 3 | Boer ni Telong | ?1856 | 22 | Sálak | | 41 | Oengáran | | 63 | Poei | 1871? | 82 | Awoe | 1922 | | | | | | | | | |
| 4 | Sibájak | | | Kawah Tjibeureum | | 43 | Wilis | | 64 | Soekaria | | 83 | Mahéngétang (Banoea Woeha) | 1918 | | | | | | | | | |
| 5 | Sinâboeng | | 23 | " Tjiparabakti | | 44 | Kloed | 1919 | 65 | Gli Moetoe | | 84 | Api Siaoe | 1922 | | | | | | | | | |
| 6 | Poesoek Boekit | | | | | 45 | Ardjoeno-Welirang | | 66 | Egon | | 85 | Roeang | 1914 | | | | | | | | | |
| 7 | Boeal Boeáli | | 24 | Gédeh | 1886 | 46 | Brómo | 1923 | a | - Lahulaki | 1910 | | | | | | | | | | | | |
| 8 | Sorik Merápi | 1917 | 25 | Tanghoeban Prâhoe | 1926 | 47 | Smêroe | 1933 | 67b | Kobetobi - perámpoean | 1921 | | NORTH CELEBES | | | | | | | | | | |
| 9 | Talámau | | | Patoeha, with Kawah | | 48 | Lamóngan | 1898 | 68 | Lewéno | | | | | | | | | | | | | |
| 10 | Mêrápi | 1927 | 26 | Tjiboeni, K Patih | | 49 | Hiang-Argopoero | | 69 | Palóweh | | 86 | Batoe Angoes - Tonkóko | 1821 | | | | | | | | | |
| 11 | Tándikat | 1917 | | and K Tjiwidej | | 50 | Raoeng | 1927 | 70 | Warirán | | 87 | Klábat | | | | | | | | | | |
| 12 | Talang, or Soelasih | 1845 | 27 | Wáyang - Windoe | | 51 | Kâwah Idjen | 1917 | 71 | Kédang | ?1849 | 88 | Lókon - Empoeng | 1893 | | | | | | | | | |
| | (Goenoeng Gédang | | 28 | Goentoer | 1843 | | | | 72 | Boling or Wéroeng | ?1870 | 89 | Mahâwoe | 1904 | | | | | | | | | |
| 13 | or Peak of Indrapoera | | 29 | Papandâjan | 1924 | | LESSER SUNDA ISL. | | 73 | Báloe Tára | 1850 | 90 | Tampoesoe - Lahéndong | | | | | | | | | | |
| | or Peak of Kerintji | | 30 | Kawah Manoek | | | | | 74 | Api Pántar | | 91 | Sopoetan - Masem - Tompáso | 1925 | | | | | | | | | |
| 14 | Koenjit | | 31 | Kawah Kamodjang | | 52 | Batoer | 1926 | | | | 92 | Oena Oena | 1838 | | | | | | | | | |
| 15 | Soembing | | 32 | Galoenggoeng - | 1918 | 53 | Agoeng | | | BANDA SEA | | | | | | | | | | | | | |
| 16 | Kâba | 1913 | | - Tilaga Bodas | 1913 | 54 | Rindjani | 1915 | 75 | Api Wétar | 1699 | | HALMAHERA c a | | | | | | | | | | |
| 17 | Dempo | 1908 | 33 | Kawah Karaha | | 55 | Tambóra | 1815 | 76 | Dammer, or Daäm | | 93 | Sibelo or Jolo | 1901 | | | | | | | | | |
| 18 | Tikindjau - Bélerang | | 34 | Tjérimai | 1805 | 56 | Api Sangéang | 1911 | 77 | Téon, or Tiau | 1893 | 94 | Iboa | 1911 | | | | | | | | | |
| | | | 35 | Slámat | 1849 | 57 | Wai Sáno | | 78 | Nila, or Lima | | 95 | Tidoekoe - Ntaga Ranoe - Sahoe | | | | | | | | | | |
| | SUNDA STRAIT | | 36 | Dieng | | 58 | Petjoléak, or Wai Kókor | | 79 | Sêroea | ?1921 | 96 | Gam Konóra | 1926 | | | | | | | | | |
| | | | 37 | Sindóro | 1906 | 59 | Inué Ré | | 80 | Mánoek | | 97 | Ternáte | 1923 | | | | | | | | | |
| 19 | Krákatau, or Rákata | 1928 | 38 | Soembing | | 60 | Inué Lóke | 1905 | 81 | Api Banda | 1722 | 98 | Moliri | 1774 | | | | | | | | | |
| | | | | | | | | | | | | 99 | Mákian | 1890 | | | | | | | | | |

*Some rules for the pronunciation*

' or ` Syllable taking the accent
~ " unaccented

| Dutch | English | Dutch | English |
|---|---|---|---|
| — | — | — | — |
| oe | as oo in "book" | ng | as in "bungle" |
| i | as ee in "see" | g | as in "give" |
| j | as y in "yellow" | | |

× Volcanoes with eruptions or with periods of increased activity later than the year 1600.

• Volcanoes in fumarolic stage; - no eruptions known after the year 1600

1917 Year of latest eruption.

# GEOLOGY OF THE NETHERLANDS EAST INDIES

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## 1. GENERAL REMARKS.

**Position of the Archipelago.** The Netherlands East Indies are situated where two great zones of crustal weakness, the Alpine and the Circum-Pacific orogenic systems, interlace. The continuations of three major arcs can be followed in the archipelago: 1. The Burman arc through the Sumatra-Java row of islands. 2. The Japanese-Philippine arc, which branches in Borneo and Celebes. 3. The New Zealand-New Guinea arc.

**Striking difference between eastern and western part.** For the geologist the difference between the eastern and western parts of the East-Indian Archipelago is one of the most striking facts with regard to the present major relief features, the growth of the mountain ranges, the distribution of volcanoes and earthquakes and the distribution of ore deposits. A line passing through the region of the Makassar Strait, approximately from north to south, divides the Archipelago into two regions and if we include Australia with the Sahul shelf for the time being as a part of our study, it will be seen that the East-Indian Archipelago consists of two great stable land-masses both partly submerged, between which lies a region of active deformation. The region between Borneo, Sumatra and Java is but a submerged shelf, known as the Sunda Shelf. Australia with the Sahul Shelf represents a similar stable area. Between these two stable regions lies a region of active deformation, which is characterized by deep elongated sea-basins separated by rising rows of islands. Active volcanoes are lacking in the stable parts of the Archipelago and epicenters of earthquakes are nearly all situated in the eastern part of the Archipelago and in the parts adjoining the Indian Ocean. As the character of the ore deposits bears an intimate relation to the character of the igneous rocks, with which they are associated, it is of interest, that basic igneous rocks

predominate in the eastern and acid igneous rocks in the western part of the Archipelago. But the boundary between these two parts is by no means so sharp in regard to the character of the igneous rocks as it is with reference to the tectonic relationships.

**Palaeogeographical aspects.** The Middle Devonian fauna of Australia has, among a great majority of Rhenish forms, a few American affinities, and an American influence is also found in southern China, but not in Burma and not in the smaller fauna of northwestern Australia. This may suggest that temporarily a dividing land-mass was present in a part of the present Archipelago. At the present time we suppose that no continental land-mass has occupied all the region now included in the Archipelago, but rather, except for minor interruptions, that the sea has separated Australia from Asia, during at least a great part of the Palaeozoic and during Mesozoic time.

The Netherlands East Indies belong to the Tethys geosyncline, which was well marked in the Mesozoic Era and extended from the Mediterranean region to the East-Indian Archipelago. It was already marked in Permian time, but a certain independence of the Permian faunas proves, that the connection between these regions was not always open. This is not surprising because littoral sediments were the principal deposits formed in this geosyncline during Permian time. In general the marine Mesozoic faunas of the East Indies agree sufficiently with those of other parts of the Tethys to make it unnecessary to speak of an East Indian faunal province. The relation between the East Indian faunas and those of the Himalayan region gradually decreases from the Lower Triassic up to the middle parts of the Dogger, whereas the relation with European faunas increases at the same time. An exception to this rule is found in the Lower Norian, where the relation to the Himalayan region increases rather suddenly. From the Callovian upwards the relation to the Himalayan region again becomes gradually closer. In the Lower Cretaceous a close relation to European faunas is found in Sumatra, while the faunas of some of the eastern islands (Sula islands, New Guinea), are closely related to Himalayan forms. Moreover characteristic endemic types appear in the middle and upper Cretaceous of parts of Sumatra and it is probable that the peculiarities of the Cretaceous faunas are connected with the beginning of the great upheaval of the vast pile of sediments that had been accumulated in the Tethys geosyncline. The more or less open communication between the East Indies region and the Mediterranean region of Europe was cut off in Eocene time, as is proved by the faunal evidence. Isolated basins came into existence many of which disappeared entirely in the Upper Tertiary.

**Unconformities.** But little can be said with certainty as regards the evolution of the East Indian region in Palaeozoic and most of Mesozoic time. Mesozoic deposits of different age which resemble in practically all respects the recent deep sea oozes have been found in several places and hence deep sea-basins must already have been in existence in the region at this time. With regard to the distribution in time and space of the crustal movements, it is apparent that strong deformation ceased in the greater part of the Archipelago at the end of Tertiary time, but has continued in the eastern part and in the region which borders upon the Indian Ocean.

If the crust moved beneath the sea, erosion did not affect the shape of the surface and no unconformities or disconformities in the succession of the strata are found. Thus on different islands the places in the geological time-scale of the erosion intervals show considerable variation. For instance a great unconformity is found in Timor between the Middle Tertiary and the Plio-Pleistocene; in Sumatra between the late Mesozoic and early Tertiary, and also between the Pliocene and the Pleistocene. In West- and Central Borneo and also in Java the Cenomanian is separated by an unconformity from folded Triassic and Jurassic sediments and intrusive granites. In Central-Borneo a younger, less striking unconformity is found in the Upper-Cretaceous or between the late Mesozoic and early Tertiary, and in Celebes and western New-Guinea a Young-Mesozoic period of folding is also indicated.

## 2. SEDIMENTARY FORMATIONS.

### AGE AND DISTRIBUTION OF CRYSTALLINE SCHISTS.

As in many other regions the crystalline schists have been considered by earlier investigators to be very ancient, probably entirely Pre-Cambrian. More recent studies have proved that an important part of those that are exposed are comparatively young, belonging to the Palaeozoic and Mesozoic ages. These rocks exhibit varying degrees of metamorphism dependent largely upon depth, intensity of deformation and to a less extent upon igneous activity. A large part of the "old schists" may be of Palaeozoic age. Rare fossils prove that part of the phyllites, silky slates, and the like, which resemble the Alpine Bündner Schiefer are of Mesozoic age.

In Sumatra the metamorphic rocks are exposed over wide areas, where they are partly of Mesozoic age. In Java these rocks are only locally developed. Considerable exposures are found in Borneo, Central-

Celebes and large parts of the northern and southeastern peninsulas of this island. Other exposures of crystalline schists are found in most of the islands of the Timor-Ceram arc, the Banggai, Sula and Obi Islands, in some islands near Halmaheira and New-Guinea, and on the latter island.

## OLDER PALAEOZOIC.

As in other parts of the Alpine mountain ranges, where the metamorphic effects have been much more pronounced than elsewhere, it is considered highly probable that older Palaeozoic rocks are represented amongst the paragneisses, micaschists, phyllites, metamorphosed limestones and other crystalline schists of the archipelago.

*Devonian* fossils (*Atrypa*, *Orthotetes*) have been reported from New-Guinea and it is possible that many of the sandstones, shales and limestones with crinoids, brachiopods and trilobites from the centralrange of this island are older than Carboniferous. Fossil evidence of the occurrence of Devonian rocks in Central-Celebes has also been reported; this discovery is not, however, generally accepted.

## CARBONIFEROUS AND PERMIAN.

Fossiliferous Upper Palaeozoic rocks, and particularly Permian, are of widespread occurrence in the East Indies. In many places the exact age of the beds is still uncertain and the data are not yet sufficiently complete to indicate where the lower boundary line of the Permian is to be drawn. Glacial beds, which are so wonderfully developed in India and Australia, have not been found among the Upper Palaeozoic rocks of the East Indies. As to whether the crystalline schists without fossils are partly of Permian and Carboniferous age, the considerations given with regard to the age and distribution of these rocks are applicable.

**Sumatra.** In Southern-Sumatra (Djambi) there is one locality (Sungi Landak) from which the brachiopods in a dark limestone (*Strophomena*, *Chonetes* and *Spirifer*) are considered to be Lower Carboniferous. In Western Djambi two distinct series of permo-carboniferous rocks have been identified. The first series consists of diabases, porphyrites. porphyries, quartz-porphyries, melaphyres and their tuffs, with lenses and layers of fossiliferous limestone. The fossils of these limestones (principally *Fusulinidae* and brachiopods) have been considered to be of Lower-Permian age. The second series is much poorer in limestone

and consists of porphyries and quartz-porphyries, keratophyres and quartz keratophyres with their tufaceous sandstones, clay shales and thick beds of conglomerates in which the pebbles are of the same volcanic rocks. Among the brachiopods, *Productus sumatrensis* has been considered to be of Upper-Permian age, but fossil plants in this same series make it probable that it is Upper-Carboniferous. Among others *Pecopteris*, *Lepidodendron*, *Stigmaria*, *Sphenophyllum*, *Calamites* and *Cordaites* have been found. And if the fossils of the first series are older, as has been admitted, their age is also Carboniferous.

In Middle-Sumatra (Highlands of Padang) the Upper Palaeozoic limestones contain corals, brachiopods, lamellibranchs, gastropods, trilobites, *Fusulinidae* and other foraminifera, which were first considered as Lower Carboniferous. Later they were called Upper-Carboniferous and still later Permian, but this last determination of their age is not generally accepted.

In northern Sumatra the trilobites *Neoproetus* and *Phillipsia*, *Fusulinidae*, corals, crinoids, brachiopods and gastropods (*Euomphalus*) have been found. They have been described partly as Upper-Carboniferous, partly as of Permian age.

**Timor and adjacent islands.** The Upper-Palaeozoic beds in this island, the greater part of which is undoubtedly properly referred to the Permian, are limestones, marls, tufaceous marls and tuffs. Beds of conglomerate and basic effusive rocks also occur. A great wealth of fossils if found here; the tufaceous marls particularly contain unusually well-preserved fossils, among which, corals, bryozoa, blastoids, crinoids, cephalopods and brachiopods are especially abundant. Endemic forms are numerous.

Of the corals the Tetracoralla are in many respects related to the Hexacoralla of Triassic time; the Tabulata are well represented. Immense collections of blastoids, belonging mostly to *Schizoblastus* have been made. Spines of echinoids are also very numerous. Of the 59 determinable genera of crinoids, which have been described, 42 genera have so far been found only in Timor. Among these occur the remarkable *Timorocrinus*, the forms with reduced arms (*Hypocrinus*), those with one arm (*Metasycocrinus* and *Monobranchiocrinus*) and those without arms (*Lageniocrinus*, *Embryocrinus*). The Permian ammonoid fauna of Timor is the richest in the world, it is especially rich in *Cyclolobidae* and *Medlicottidae*, but relatively poor in *Ceratitoidea*. Anachronistic genera from the Carboniferous, vigorous specializing genera characteristic of Permian and some prophetic Triassic races are found together. From Lower- to Upper-Permian the following beds have been distinguished:

| | TIMOR | INDIA | URALS |
|---|---|---|---|
| NEO-DYAS | | EPISAGECERAS AND XENODISCUS BEDS | |
| | AMARASSI BEDS WITH CYCLOLOBUS | CYCLOLOBUS ZONE | |
| | | XENASPIS BEDS | |
| | BASLEO BEDS WITH WAAGENOCERAS | | |
| PALAEO-DYAS | BITAUNI BEDS WITH PERRINITES | | ARTINSK SERIES |
| | | | |
| | SOMOHOLE BEDS WITH MARATHONITES | | |

The brachiopods are abundant but are not of great stratigraphic importance and are poor in endemic forms. Limestones composed almost exclusively of tests of *Fusulina* are found at various places.

Fossiliferous Permian beds have been noted in other islands of the Timor row. It is interesting to state, that *Paralegoceras*, one of the ammonites of the island of Letti is similar if not identical to *Gastrioceras* of the Irwin River coal-field in Western-Australia.

**New-Guinea.** In New-Guinea Palaeozoic rocks, which are in part of Permian age, occur in the high central range and in the northwestern peninsula.

## TRIASSIC.

Of all the different facies of the Triassic only one, the cephalopod, is found with characteristic fossils from Lower- to Upper Triassic. This facies is known to exist in the island of Timor only and resembles the Alpine cephalopod limestones near Halstatt.

**Sumatra, Borneo and adjacent islands.** In western Borneo *Monotis salinaria* has been found in a series of rocks consisting principally of sandstones and clay shales, which proves the presence of Upper Triassic rocks in this part of the island. Upper Trias beds seem to be of widespread occurrence in Sumatra. They consist principally of clay shales, limestones and sandstones. In northern Sumatra beds with *Halobia* and *Daonella* are probably Lower Carnian in age. A fauna, probably of Lower Norian age, has been found in the Highlands of Padang.

Triassic rocks have also been found in the Riouw archipelago near Malacca.

**Celebes and adjacent islands.** In the southeastern peninsula and the island of Buton a series of clay shales, sandstones and limestones occurs, in which *Halobia*, *Daonella* and other fossils have been found.

**Moluccas.** Sandstones, shales, marls and limestones with Triassic fossils occur on the islands of Buru, Ceram, Ambon and Misool. The oldest beds of which the age is proved by fossil evidence are Lower Carnian, but the lowest horizon is not yet exactly known. Cherts full of radiolaria are associated with these rocks in Ceram and Ambon, but it is not known with certainty whether they are of Triassic age.

**Timor.** In this island the Triassic is exhibited in its most varied development. Several different facies representing simultaneous periods of deposition under widely different conditions have been brought together here by intense folding and overthrusting.

The Lower Trias (Scythian) is known in the cephalopod facies only. It has been divided into: *Sibirites* limestones, *Owenites* limestones and *Meekoceras* limestones.

In the Middle Trias, perhaps already in the Anisian, but certainly in the Ladinian, the differentiation of the Triassic facies begins. Some of the Upper Triassic facies, such as shales and marls with *Daonella*, shales with *Globigerinidae*, radiolarites and a series of sandstones and shales, resembling the Flysch of the Alps, are in part of Middle Triassic age.

In the Upper Trias, particularly in the Norian, the differentiation of the facies reaches its maximum.

The cephalopod limestones with interbedded tufaceous material are sometimes entirely filled with ammonites, nautiloids, *Aulacoceras*, *Dictyonites*, *Atractites* and *Heterastridium* and contain pelycopods, gastropods, foraminifera and some brachiopods (Fig. 1). The ammonites belong principally to the leiostrake forms *Areestes*, *Cladiscites*, *Discophyllites*, some trachyostrake forms are, however, abundant, as *Halorites* (cf. *macer*).

The pelecypod facies is characterized by limestones and shales with *Halobia*, marls, calcareous shales with *Monotis* and siliceous limestones, shales and cherts, which are partly filled with radiolaria.

The Fatu limestone facies consists of masses of mostly oolitic limestones, coral reefs, stratified brownish and reddish limestones with pelecypods, ammonites and some gastropods and brachiopods.

The Flysch facies with *Daonella* consists of sandstones, clay shales, which often contain concretions rich in iron, thin beds of marl and breccias (partly echinoderm limestone breccias with stems of *Isocrinus*).

*Photo L. J. C. van Es.*

Fig. 1. Triassic cephalopod limestone from the island of Timor.

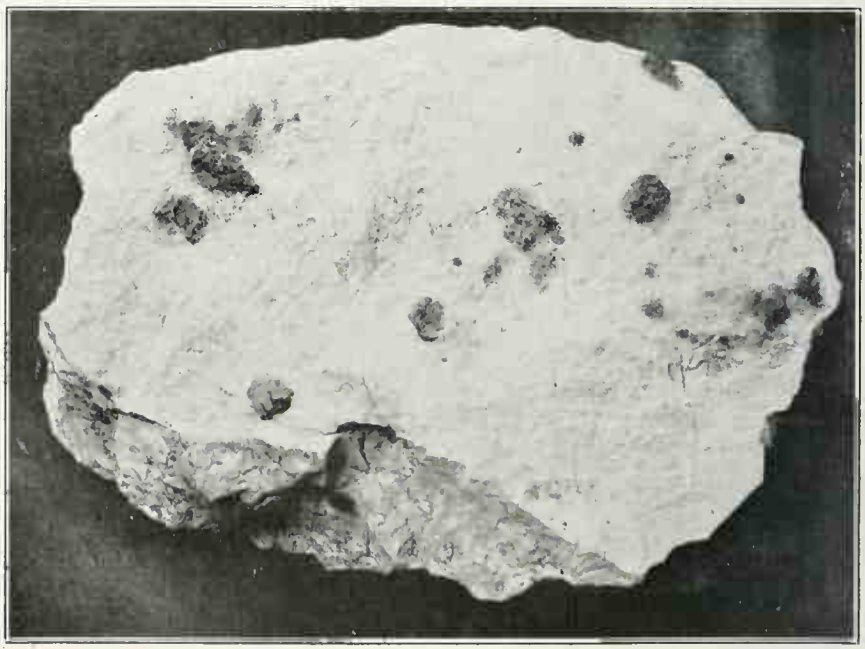


*Photo P. Kruizinga.*

Fig. 2. Upper Jurassic Marl with Radiolaria and concretions of manganese from the island of Rotti.

Basic eruptive rocks (augite diabases, diabase porphyrites etc.) are partly Upper Triassic, partly they are intruded in the Upper Trias and are obviously younger.

The Rhaetic is perhaps represented by the cephalopod facies. Bituminous limestones and dark shales with *Choristoceras* and *Myophoria* are of this age. But little is known about the beds through which the Norian passes upward into the Jurassic.

**Islands near Timor.** The pelecypod facies is found in most of the other islands of the Timor row. The fossils belong to the Upper Trias. Sometimes cherts full of radiolaria are associated with these rocks.

## JURASSIC.

These rocks have partly been metamorphosed and fossil evidence is very scarce. The Jurassic, like the Triassic, is exhibited in its most fossiliferous development in the eastern part of the Archipelago.

**Sumatra.** Dynamometamorphic phyllitic and silky slates with interbedded sandstones, quartzites and some limestones are of widespread occurrence and some rare fossils identify these rocks as partly of Jurassic age. *Pentacrinus*, corals similar to *Montlivaultia*, *Belemnites* are probably Lower Jurassic; pelecypods (*Astarte*, *Lucina*, *Cypricardium*, etc.) may belong to the Middle Dogger. Limestones with *Myriopora* and *Itieria* are Upper Jurassic in age.

**Java.** Crystalline schists (partly chlorite schists), associated with basic eruptive rocks and radiolarian cherts, which are of local occurrence, may be partly of Jurassic age.

**Borneo.** The Lias (*Harpoceras radians* and lamellibranchs) is represented in a series of sandstones, shales and limestones in the western part of the island. Lamellibranchs and gastropods (*Exelissa*) are probably Middle Jurassic and *Perisphinctes* Upper Jurassic. The Danau formation in the Central-Borneo mountain chains (in which radiolaria are numerous, particularly in the hornstones and other siliceous rocks and in the diabase tuffs), may be of Jurassic age, but it may be partly Triassic as well.

**Celebes.** Greyish blue shales with belemnites in the eastern peninsula of the island are of Jurassic age. In the western part of this peninsula, in the central part of the island and in the northern peninsula limestones, shales and cherts, with which tufaceous rocks are sometimes associated, have been considered to be partly of Jurassic age. Radiolaria are often found in these rocks.

**Moluccas.** In the row of islands Sula islands- Obi islands-Misool, the Upper Lias and Dogger are represented; on Buru and Ceram Lias and Dogger have not been found and the oldest Jurassic strata belong to the Upper Jurassic. In the Sula islands Aalenian (*Harpoceras, Grammoceras, Coeloceras*), Bajocian (*Stephanoceras*), Callovian (*Belemnites, Phylloceras, Oppelia, Stephanoceras, Sphaeroceras, Macrocephalites, Perisphinctes, Idoceras*), and Oxfordian (*Belemnites, Phylloceras, Oppelia, Macrocephalites, Perisphinctes, Peltoceras*) are represented. The rocks are principally dark clay shales and calcareous shales with layers and concretions of calcareous (and sometimes quite siliceous) rocks. In Misool the Jurassic beds range from the Upper Lias to the uppermost Jurassic, Middle and Upper Dogger seem to be absent. Ammonites, belemnites and lamellibranchs (*Aucella, Inoceramus*) are numerous.

In Ceram and Buru calcareous shales with lamellibranchs (*Inoceramus, Aucella malayomaorica*) and belemnites and siliceous limestones with nodules of chert and belemnites are of Upper Jurassic, partly Oxfordian, age. Tufaceous rocks in Buru with *Phylloceras, Perisphinctes*, brachiopods and pelecypods are of Lower Oxfordian age.

**Timor row of islands.** Particularly in Timor and Rotti the Jurassic sediments have been studied in some detail. Deposits similar to the cephalopod, pelecypod and Fatu limestone facies of the Triassic are known in the Lower Jurassic. However the main development of the Lias consists of clay shales, limestones and argillaceous limestones of which the faunal characters are somewhat similar to those of the cephalopod and pelecypod facies of the Upper Trias. The zones of the Lias are all represented, cephalopods are particularly numerous (*Arietites, Schlotheimia, Oxynoticeras, Aegoceras, Lytoceras, Phylloceras, Dactylioceras*, etc.), but pelycopods and brachiopods are also found. Gastropods are rare. Ferruginous clay shales with concretions of clay iron stone (with *Macrocephalites, Stephanoceras* etc.) belong to the Dogger. More or less argillaceous limestones and calcareous shales (with *Perisphinctes, Oppelia, Aucella* etc.) are of Upper Jurassic (Oxfordian) age. Beds which often show the characteristics of deep-sea deposits are found associated with these rocks. Nodules of manganese and concretions of chert, which are full of tests of radiolaria are found in them (Fig. 2).

**New-Guinea.** To the north and to the south of the high central mountain range Jurassic rocks must be widespread. The development seems to be similar to that of the Jurassic in the Sula islands, which has a wide horizontal distribution from the Himalayas to New-Zealand. The Jurassic is also found in the northwestern peninsula.

## CRETACEOUS.

The Lower Cretaceous is known with certainty only in the Sula islands, New Guinea and Sumatra; the Upper Cretaceous has a much more extensive development.

**Sumatra.** The Jurassic dynamo-metamorphic rocks pass upwards into similar rocks of Lower and Middle and perhaps even Upper Cretaceous age. *Nerinea*, *Neocomites*, *Thurmannia*, *Kilianella*, *Oosterella*, *Astieria*, *Spatangidae* and lamellibranchs have been found.

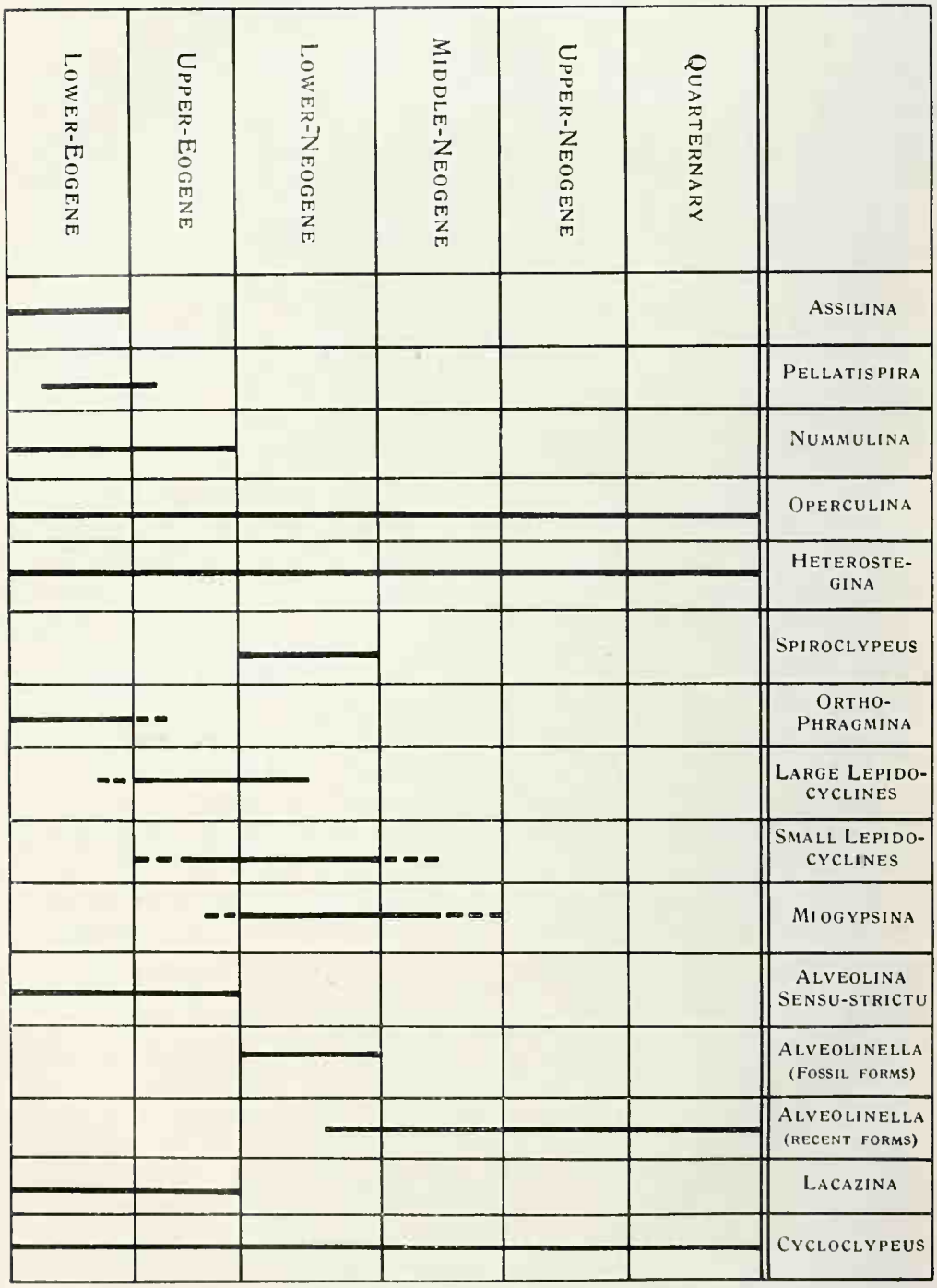
**Java.** Limestones with *Orbitolina concava* are found in the residencies of Bagelen and Banjumas.

**Borneo.** The Cretaceous begins with the Cenomanian nearly everywhere in this island. Basal conglomerates of this age have been found in different places. *Orbitolina concava*, ammonites (*Knemoceras*, *Schloenbachia*) and many other fossils have been found. Rocks with a Senonian fauna occur in southeastern Borneo.

**Eastern part of the Archipelago.** In the Sula islands and New-Guinea the Lower Cretaceous is known in the same facies as the Middle and Upper Jurassic of these islands. The Valanginian with *Phylloceras*, *Bochianites*, *Streblites*, *Himalayites* and *Hoplites* is represented. It is possible, that globigerina limestones from the Sula islands are Upper-Cretaceous. In most of the islands of the eastern part the Lower Cretaceous seems to be absent. A series of oceanic deposits in which more or less siliceous limestones with planctonic foraminifera (*Discorbina canaliculata*, *Pseudotextularia globulosa* and *Globigerinidae*) predominate, has an extensive development from Celebes to Halmaheira and in the Timor-Ceram row of islands. At some places tufaceous material is interbedded with the limestones. In part they certainly are Turonian, they probably also represent the Cenomanian. A most interesting occurrence of red deep-sea clay shales has been found in the island of Timor. Besides radiolaria, the clay shale contains numerous nodules of manganese and a great number of fragments of teeth, which principally belong to the sharks of the family *Lamnidae*. The deposits of the upper part of the Upper Cretaceous prove the existence of more shallow seas in the entire archipelago.

## TERTIARY.

It is difficult to apply the European subdivisions of the Tertiary (Eocene, Oligocene, Miocene and Pliocene) to the Tertiary sequence of rocks as found in the East-Indian archipelago. The palaeontological evidence, as indicated by the distinct character of the foraminifera, permits a precise separation of some of the subdivisions. The following stratigraphy has been proposed:


Lower-Eogene
Upper-Eogene
Lower-Neogene
Middle-Neogene
Upper-Neogene
Quarternary
Assilina
Pellatispira
Nummulina
Operculina
Heterostegina
Spiroclypeus
Orthophragmina
Large Lepidocyclines
Small Lepidocyclines
Miogypsina
Alveolina sensu-strictu
Alveolinella (Fossil forms)
Alveolinella (recent forms)
Lacazina
Cycloclypeus

Another method to determine the age of the Tertiary deposits has been used, particularly for those of the island of Java. The age is found by estimating the percentage of recent species in the different deposits. The percentage estimates of Mollusca for some localities in Java gave the following results:

| | | |
|---|---|---|
| Quaternary ..... | 86—90 | % recent species. |
| Pliocene..... | 51—61 | ,, ,, ,, |
| Upper-Miocene ..... | 27—45 | ,, ,, ,, |
| Lower-Miocene ..... | 6.8—21.6 | ,, ,, ,, |

**Sumatra.** A distinct unconformity separates the Eogene sediments from the Pre-Tertiary rocks. In their lower parts conglomerates are found, while in the upper part of the Eogene series quartz-sandstones predominate. In South- and Central-Sumatra coal seams are interbedded with the sandstones. In Northern Sumatra the Eogene series are partly marine (beds with *Orthophragmina*) and a similar difference between the facies of different parts of the island is also characteristic of the Neogene series, which also show a greater tendency to a more continental facies in the southern part of the island.

Volcanic material is found in the Neogene sediments, particulary in their upper parts and considerable quantities of lignite are also found. here. The deposits of lignite are rare in northern Sumatra, but increase towards the southeast and are particularly thick and numerous in Palembang. The uppermost part of the Neogene consists of tufaceous rocks, principally of liparitic and dacitic composition.

**Java.** Only 0.5 percent of the surface of Java consists of Eocene sediments. They are conglomerates, sandstones, shales and limestones with *Nummulites*, *Orthophragmina* and *Cycloclypeus*. Coal seams are found in the western part of the island.

The Neogene sediments have an extensive development. In the northern part from Semarang to the island of Madura a facies rich in limestone with *Lepidocyclina* etc. is found. In northern Rembang beds of lignite are interbedded with the Neogene sediments. More to the south, from Surabaia to the west marls with *Globigerinidae* predominate in the Neogene series, particularly in their lower parts. Still more to the south a similar zone, in which marls predominate, can probably be followed from Central-Java to the western part of the island. In the southern part of the island limestones have an extensive development. Particularly in its upper part the Neogene series are rich in materials

of volcanic origin, to the south these materials increase also in the lower part of the series. The petrographical study of the sediments has proved that an old land mass existed to the north of the present island.

Of particular interest are the Plio-Pleistocene deposits with bones of mammals (Trinil-beds), in which *Pithecantropus erectus* has been found.

**Borneo.** As compared with Java, the Tertiary of Borneo has a more continental facies. Considerable quantities of shales and sandstones with coal seams are found from the Lower to the Upper Tertiary.

In the southeastern part of the island the Eogene with *Nummulites* and *Orthophragmina* consists of sandstones, shales and coal seams in its lower part; sandstones, marls and limestones form the middle part and the upper part, which belongs to the Oligocene consists of thick beds of limestone with large lepidocyclines. The Neogene with *Lepidocyclina* and other foraminifera, in which coal seams are also found, has a great thickness.

In eastern Borneo the principal Tertiary deposits belong to the Neogene, which has a thickness of several thousand meters. Sandstones, shales, coal seams, marls, some limestones and also tufaceous material are the principal deposits.

The Tertiary of western Borneo and that of the western part of Central-Borneo is very different from the Tertiary of the eastern part of the island. The deposits never have a very great thickness, sandstones predominate and a typical marine fauna has never been found. The species of *Corbula, Cyrena, Arca, Melania, Paludomus* in these deposits are different from living species and it is probable that the Eogene and at least a part of the Neogene is represented. Effusive material is interbedded in considerable quantity.

**Celebes.** The Eogene of South-Celebes begins with a conglomerate at the base of a sandstone series with coal seams. They are covered with thick limestones with *Nummulites* and *Orthophragmina*, which partly belong to the Lower Neogene with *Lepidocyclina*. Particularly in the southern part of Central-Celebes the Eogene deposits prove a strong volcanic activity, while reddish marls, shales, sandstones and some limestones, which are also found more to the north, partly belong to the Lower Eogene. Eogene limestones of the eastern peninsula probably pass upward into the Lower Neogene.

The Neogene deposits, of which some have been mentioned already, are rich in volcanic material, except in the eastern peninsula. In the southern part of the island beds of lignite have been found, but for the greater part the deposits are of marine origin.

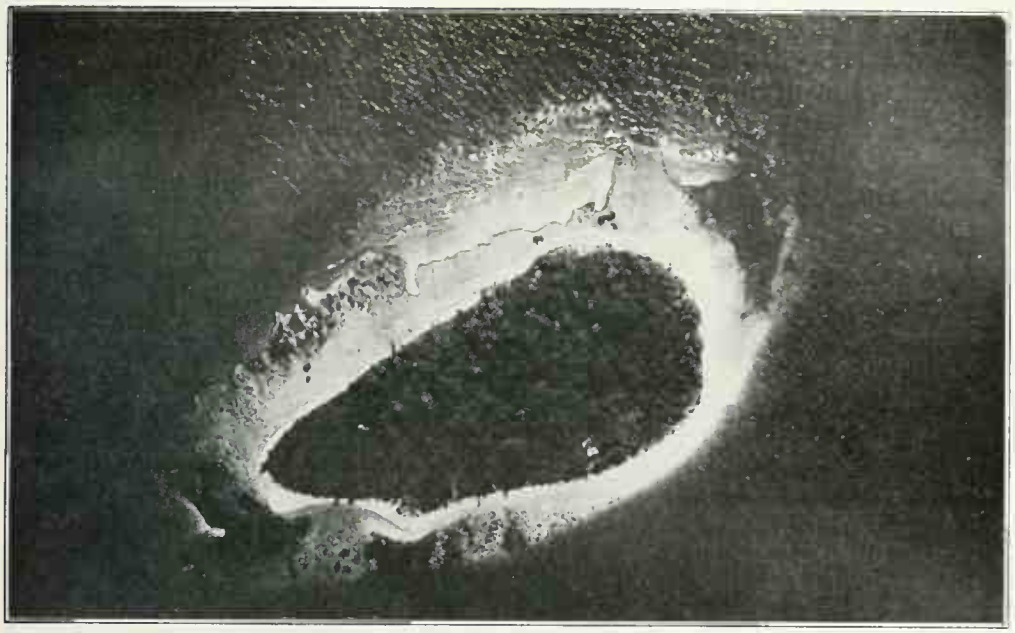


*Photo Aerial Service. Neth. Colon. Army.*

Fig. 3. The island Hoorn, to the North of Batavia, with a fringing reef, as seen from a height of about 1250 m.

*Photo Aerial Service, Neth. Colon. Army.*

Fig. 4. The island Edam, to the North of Batavia, with af fringing reef.

The volcanic material in the Tertiary rocks of Celebes is partly derived from subalkaline (liparites to basalts) partly from alkaline magma (leucite- and nepheline rocks).

**Other islands.** The typical development of the Lower Tertiary in the eastern part of the Archipelago consists of limestones with *Nummulites* and *Alveolina*. But deposits of terrigenous origin are also found.

In general the deposits of Neogene age consist of sandstones, shales and limestones. In several places the Upper Tertiary is rich in materials of volcanic origin and beds of lignite are found in different places.

### QUATERNARY.

The quaternary deposits partly consist of the waste of the highlands; both fluviatile and marine deposits of sandstones, clay, conglomerates and breccias were formed. In the regions with active and extinct volcanoes the Quaternary is rich in deposits of volcanic origin. The most conspicuous rocks of the Quaternary, which are partly of Pliocene age, are the upheaved fringing reefs, barrier reefs and atolls of the unstable areas. Coral reefs at low altitudes, barrier reefs and atolls may have been formed by a movement of the land only, by a movement of the sea-level only or by both at the same time.

## 3. IGNEOUS ROCKS.

The igneous rocks of the Archipelago mostly belong to the calc-alkaline series. The alkaline rocks have a very limited distribution and are rarely found in great masses.

The granitic to dioritic rocks are in part op pre-Mesozoic age, as is proved by granitic pebbles in late Palaeozoic rocks in Sumatra. Many of the granites of Sumatra and Borneo are of Mesozoic age and Tertiary granites and diorites are found in several localities, for example Java and Celebes.

Basic intrusive rocks (gabbros, peridotites, serpentines, diabases) and their widespread dynamo-metamorphic equivalents are partly of pre-Mesozoic (Late Palaeozoic) age, but many are of Mesozoic, partly Cretaceous, age. The occurence of Tertiary gabbros and peridotites is known, or their presence is highly probable, in Celebes and many other places.

Foyaitic to theralitic rocks have a limited distribution; in southern Celebes they are intrusive in Tertiary rocks. Their age is unknown in Timor and adjacent islands and in New Guinea.

Some of the more acid effusive rocks (rhyolites and quartz porphyries to andesites and porphyrites with the keratophyres, alkalirhyolites, alkalitrachytes and trachyandesites) are found in association with the Permian deposits of Sumatra, with the Permian and Lower Mesozoic sediments of Timor and adjacent islands, and with younger Mesozoic rocks in the Moluccas. The Tertiary was a period of great volcanic activity and material of volcanic origin which belongs in part to this group is of widespread occurrence. The rocks of the extinct and active volcanoes are for the greater part pyroxene andesites and basalts, though more acid rocks (even liparites, in Celebes, Sumatra, Bantam etc.) are also found.

The basalts, melaphyres and their tuffs, effusive diabases and serpentines, and metamorphic basic eruptive rocks are of late Palaeozoic age in Sumatra, Timor and adjacent islands. Such rocks are also found in the Triassic and in younger Mesozoic deposits (for example in the Danau formation of Borneo). In the Tertiary they are of widespread occurrence. Part of the serpentine of the Archipelago seams to be Tertiary in age and of volcanic origin. The extinct and active volcanoes consist in part of materials from basaltic magma.

The leucite and nepheline-bearing effusive rocks have a limited distribution. Some of them are associated with Eocene deposits in the tufaceous series of south Central Celebes. In Celebes, Java and Sumbawa leucite and nepheline-bearing effusive rocks of Neogene and even later age are known.

## 4. STRUCTURAL FEATURES.

The records of two phases of diastrophism are easily read. These are the Cretaceous to Tertiary and the youngest movements, of which the latter still continue and are limited to a much smaller area. The trend-lines and the character of the older movements will be considered first, then the trend-lines and the character of the youngest movements. In conclusion a brief review of the relationship between volcanicity, seismicity and successive movements of the earth's crust will be given.

**The Late Mesozoic and Tertiary Structures.** Series of branching trend lines are characteristic of large parts of the Archipelago. In Borneo the folded ranges with a main trend of north-northeast to south-southwest are closely crowded together in the northeastern part of the island. From here the main strikes diverge to the southwest. In Sumatra the branching of the trend lines, from the northwestern part of the island toward the southeast, is not so pronounced. It has been suggested, that the

highest and the lower eastern parts of the Barisan mountains in Djambi are parts of a large overthrust sheet. The Tertiary rocks of Sumatra have generally been folded, often in more or less regular broad anticlines and synclines. The Tertiary mountain plan of Celebes may be thought of as comprising two strongly diverging trend-lines of which the northern recurves towards the north in the direction of the Philippine islands.

There are some indications that virgations of the older trend-lines occur in a somewhat similar manner in the eastern part of the Archipelago, but their reconstruction cannot be made complete, because the region is mostly below the sea-level and the older folds are in many places cut off by the present coast lines. Studied in profile, very complicated structures have been found in many of the islands of the Timor-Ceram arc. In Timor the structure is as a rule chaotic and similar to that of the higher overthrust sheets of eastern Switzerland. Isolated rock peaks of Triassic coral reefs are found resting on younger oceanic deposits (Fig. 5 and 6). The relative movement of the thrusting in the Timor-Ceram arc seems to be from the Banda Sea outward, except in Buru.

It does not seem improbable that recumbent folds, imbricated structures or overthrusts occur in the great median mountain range of New Guinea. These mountains bear, towards the lowlands to the south and to Australia beyond, a relation somewhat similar to that borne by the Himalayas towards India.

A great part of Java and the Lesser Sunda islands is covered with volcanoes. The main strike in the small areas of pre-Tertiary rocks is about the same as that of the Tertiary anticlines and synclines and more or less parallel to the longer axis of the island. A relative movement toward the north is indicated in the folds of some of the pre-Tertiary rocks.

**The youngest structures.** The youngest movements have been restricted mainly to the eastern part of the Archipelago and to those parts of the western islands which border on the Indian Ocean. Rising rows of islands with strongly fractured surfaces and deep elongated sea-basins are characteristic of these unstable parts. The distribution and arrangement of the numerous fractures and faults in some cases indicate important horizontal movements, as in Western Java and in the Timor-Ceram row of islands. The striking relation between the unsymmetrical reefcaps and the outward bends of the latter islands also gives evidence, that the movements were not only vertical. The amount of vertical movement can be derived from the position of the elevated modern coral reefs, which for example occur at an elevation

*Photo G. A. F. Molengraaff.*

Fig. 5. Overthrust structure in Central Timor. The "Stone of Kapan", one of the numerous "Fatus" or "Klippen" of Upper Triassic coralline limestone.

*Photo F. M. Huneriwadel.*

Fig. 6. Fatu Leo in Western Timor.

of 1300 meters in the central parts of the island of Timor. The pitch of the reef caps is very slight, which proves the small differences in rate of vertical movements, while the strong bendings of some rows of islands indicate the importance of the rate and the differences in rate of horizontal movement, which have often been too much neglected. As to the absolute horizontal movements of the parts of the Archipelago undergoing derformation, there is no way of inferring the amount from the surface characters of the present geanticlines.

The basins in the central part of Celebes, which are arranged in straight lines and are more or less parallel to the geanticlinal axes, have been explained as gaping fractures on the convex side of the bended crust. In the main, simple geanticlinal bendings are not adequate to account for the numerous longitudinal fractures on the islands of the East-Indies.

In large parts of the western Archipelago, the mountains reached the mature stage at the end of the Tertiary period and are now gradually dying off; in the eastern part and near the Indian Ocean embryonic stages are at present in full growth. In the future the latter may develop into a continental mountain range of the Alpine type if compressive and not tensional stress prevails. That two rows of islands have evolved into one row is proved by the island of Timor, which has passed a stage similar to that represented by the present Teninber islands, which consist of two rows. On a smaller scale this is the same evolution as may be passed through by the two rows of islands in the southeastern part of the Archipelago as a whole.

**Seismicity and volcanicity in relation to structure.** The independence of seismicity and volcanicity is very striking in the East Indian Archipelago. But for both phenomena there is a relationship to successive movements of the earth's crust and volcanoes and earthquakes are characteristic for the present unstable portions. The unstable belts occupy a much larger surface than the volcanic belts, but volcanic rocks cover vast areas in the unstable regions where active volcanoes are not found now. Many volcanoes are arranged on more or less straight lines, sometimes these lines coincide with longitudinal, often they coincide with transverse or diagonal fractures. In the arcs about the Banda Sea an interesting relation between the distribution of the active volcanic vents and the crustal movements is demonstrated. The volcanoes are extinct where the two rows are nearest to each other and the volcanic action was more prolonged in proportion as the island rows are further separated. The two geanticlines are very similar to the successive folds formed in various experiments. Australia represents the resistant body. The oldest fold of the experiments shows a tendency towards overturning and over-

thrusting after a certain stage of development and this may be the reason, why in the outer row of islands and in the parts of the inner row which are in the neighbourhood of the Australian continental shelf, the volcanic vents have become stopped up.

The epicenters of earthquakes in the East-Indian Archipelago lie for the most part under water, they are found in the unstable eastern part and in the unstable parts adjoining the Indian Ocean. When they are on land there is a close relationship between the epicentral areas and fault lines. As the principal earthquakes are of tectonic origin, there must be some relationship between the epicenters and the characteristics of the geanticlinal movements in space. If there are no strong differences in the velocity of movement along the axis of the geanticline, the epicenters will be arranged along longitudinal tectonic lines. Examples are the Benkulen earthquake of 1924 and the Ceram earth- and seaquake of 1899. In many cases the differences in velocity for the neighbouring parts of the horizontal projection of the geanticlinal axis are rather strong and in addition to movements along longitudinal tectonic lines epicenters may also be expected along more or less transverse or diagonal tectonic lines, as in the neighbourhood of Sunda Strait. The intersections of longitudinal and transverse seismotectonic lines are points of high seismicity, as in the island of Ambon in the neighbourhood of Manipa Strait between Ceram and Buru, where transverse fractures are connected with important horizontal displacements.

**Coral reefs and Reef-caps with special reference to crustal movement and movement of the sea-level.** Coral reefs at low altitudes, barrier reefs and atolls may have been formed by a vertical movement of the land only, by a vertical movement of the sea-level only, or by both at the same time. If the displacements of the shore-lines are different within relatively short distances or if coral reefs are found at high altitudes the land has certainly moved in a vertical direction. The horizontal movement of the land may be considerable but generally the coral reefs and reef-caps give clear evidence of the vertical movement only.

In the parts of the western archipelago which are more or less stable with regard to vertical movements, the Great Sunda barrier reef extends roughly parallel to the southeastern coast of Borneo over a lenght of about 500 kilometers, the greatest distance from the nearest point of the coast of Borneo being 230 kilometers. This great barrier reef evidently originated from a fringing reef, which in late Pleistocene time extended along the eastern coast of the former Sunda Land, which is now partly submerged and included the great Sunda Shelf, which lies between

Java, Sumatra and Borneo and is the most extensive sea-covered shelf on the globe.

In the rows of islands of the eastern archipelago the vertical displacements of the land are very striking. In the Timor arc, which can be cited as an example, the pitch of the geanticlinal axis is very slight and can be calculated from the position of the elevated modern reefs. Their elevation which is 1300 meters in the central part of the island of Timor decreases both to the west and to the east. Luang, which lies more than 400 kilometers away from it is the first island to the east where no elevated reefs are found. Transverse fractures in the reef caps coincide with bending points of the geanticlinal axis and may be the result of differences in velocity of horizontal movement. Reef-caps which are unsymmetrical in a section at right angles to the geanticlinal axis coincide with marked outward bends of the row of islands, as in the islands of Rotti and Jamdena (Tenimber group). This may be the result of a shifting in a horizontal direction.

The rising geanticline may temporarily consist of secondary geanticlines with intermediate secondary geosynclines as in the Tenimber islands, which show a stage of evolution that has been passed by the present island of Timor. The Tukang Besi islands to the southeast of Celebes consist of two rows of barrier reefs and atolls, which alternate with two rows of islands with upheaved coral reefs.

A thin reef-cap without terraces proves a more or less uniform velocity of upheaval. Many reef-caps have a terraced appearance. Very thick reefs and upheaved atolls may prove that periods of submergence alternated with periods of upheaval. Many examples of all these cases are amply demonstrated in the East-Indian Archipelago.

## 5. ECONOMIC GEOLOGY.

The metalliferous deposits of more or less importance are those of gold, silver, iron, manganese, copper, lead, zinc, tin, nickel, platinum, chromium, tungsten, mercury, molybdenum, bismuth, antimony and arsenic. The deposits of non-metals include those of petroleum, coal, diamonds, iodine, sulphur, phosphate, magnesite and water.

In the present stages of exploitation the principal deposits of economic importance are petroleum, coal, tin, gold and silver. Important quantities of iron ore of a good quality have been found, but are not yet being exploited. In Borneo there is a production on a small scale of diamonds. Iodine is found in the water of natural springs, nearly the total production has come from the Residency of Surabaia (Java). Some sulphur is exploited in the neighbourhood of solfataric centers

principally by natives. Small amounts of manganese ore have been produced, nearly entirely from the Residency of Djokdjakarta (Java). Java should be mentioned especially for its artesian wells. The many more or less isolated volcanic mountains slope gradually down to the plains and the artesian water is obtained from young deposits, most of the wells being in the low coastal areas.

Some more details will be given about the deposits of petroleum, coal, tin, gold, silver, and iron.

**Petroleum.** The principal oil strata are of Late Tertiary age. The sediments of the present oil bearing belt of eastern Sumatra, northern Java and eastern Borneo were formed in a geosynclinal area, which in Neogene time surrounded a continuous land-mass, which was much smaller than the area now covered by the western islands and the Java Sea. The folded sediments furnish ideal examples of oil anticlines in many places. Erosion of the oil-bearing strata, complicated structures, submergence below the sea-level and deposition of younger (partly volcanic) deposits of considerable thickness have greatly limited the distribution of producing oil fields.

In the eastern part of the archipelago oil is exploited in the island of Ceram only, but oil springs, natural gas and mud volcanoes are found in various islands. The oil deposits are in part of Neogene age. Bituminous shales are found in the Upper Trias and oil and gases emanate from these rocks in the Timor-Ceram row of islands. But large overthrusts are found in these islands and the primary deposit is not always necessarily of Upper Triassic age.

**Coal.** Coal is exploited in Sumatra and in and near Borneo from Old and Young Tertiary beds. Coal of Pliocene age, which has been metamorphosed by intrusions of andesite, is exploited in southeastern Sumatra in the Lematang coal fields.

The Upper Tertiary oil-bearing geosynclinal deposits of eastern Sumatra, northern Java and eastern Borneo are in part rich in lignite; in the northern part of this area (northern Sumatra) and in eastern Java coal deposits are rare. Minor deposits of Young Tertiary coal have been found in several other places.

The two largest Old Tertiary coal basins are the Ombilin coal field in the Highlands of Padang, Sumatra and the Old Tertiary area in southern Borneo, which is apparently connected with the coal area in the northern part of the adjacent island of Pulu Laut. On the south coast of west Java and in south Celebes Old Tertiary coals are found in several places.

**Tin.** Detrital deposits are by far the most important source of tin and have long been the only supply of tin ore in the well known tin islands to the southeast of the Malay Peninsula (the Riouw Archipelago, Banka and Billiton). Less important deposits are found along the courses of the Kampar and Rokan rivers and their tributaries in eastern Sumatra.

The stanniferous detritus of the tin islands is found as eluvial (kulit) deposits, as valley (kollong) deposits and as kulit-kollong deposits. The lowermost deposits are found in the islands at a depth of several meters below the present sea-level and the so-called sea tin demonstrates the submarine prolongation of a number of the river valleys. The drowned character of these deposits is due to the rise of the sea-level since the Pleistocene.

The primary deposits of tin ore are partly found in the granites as greisen-deposits, partly they occur outside the granites in the sediments. A large part of the tin-bearing deposits in the sedimentary rocks consists mainly of quartz with cassiterite; some deposits are rich in sulphides and are connected by transitional stages with deposits containing iron, mainly magnetite.

**Gold and silver.** As in other regions of the Tertiary mountains that lie about the borders of the Pacific Ocean primary deposits of gold and silver are associated with Tertiary eruptive rocks. The deposits are for the most part normal fissure veins, they are associated with andesites, principally augite andesites, but quite often a more acid rock (dacite, trachyte) is also found in contact with the deposits. In the Lebong region in Benkulen of western Sumatra, where many deposits of commercial importance have been found, gold and silver mines are found along faults and fractures of which three systems have been identified. As to their composition the ores can be divided in a selenium-bearing, a manganese-bearing and an sulphide group. At Totok in northern Celebes an Old Miocene limestone has been silicified and native gold is found in the quartz of the silicified parts and also in secondary calcite.

Granitic rocks of Pre-Tertiary age and more or less metamorphic sediments contain siliceous gold-bearing veins of small dimensions but thus far no veins of any great importance have been found. The eluvial and stream deposits which have resulted from the disintegration of the rocks containing the gold-bearing veins have been of importance through native exploitation only, as in Sumatra, western Borneo and Timor.

**Iron and Nickel.** Iron ore has been deposited by magmatic differentiation and by emanation in veins in association with grano-dioritic

magmas or in contactmetamorphic sediments, mostly limestones. They are found principally in the western part of the Archipelago. Important residual deposits have been formed by the weathering of basic and ultrabasic rocks, which are principally of widespread occurrence in the eastern part of the Archipelago. Very important quantities of iron ore of a good quality have been found in the lake region of central Celebes, in the islands near Strait Laut and the neighbouring parts of southeastern Borneo. They belong, at least for the greater part, to a lateritic product of weathering and are of the same type as the well known Cuban ores. Nickel ores are found in the same areas; their occurrence is very similar to those of New Caledonia. They are found along fractures in the basic igneous rocks and in the loose weathered blocks from these rocks, which are known for their iron content.

Alluvial deposits with magnetite and titanic iron ore have their ultimate origin in volcanic deposits, such as the black sands of the south coast of Java.

# ASTRONOMY.

by Dr. A. PANNEKOEK,

*Professor of Astronomy at the University of Amsterdam.*

Astronomy is not a quite new science in Java. It is not generally known that as early as the 18th century Batavia was the seat of an observatory better equipped than many European observatories at that time. It had been built by J. M. MOHR, by birth a German from Eppingen (Pfaltz), who had studied theology at Groningen and was from 1737 to 1775 minister of the Portuguese church at Batavia, appointed by the East India Company. He was a zealous observer of the stars as well as of other remarkable phenomena of the tropical world, and he often sent reports on his observations to Harlem, the seat of the "Hollandsche Maatschappij van Wetenschappen", of which he was a member. By his marriage he was wealthy enough to order excellent instruments from Europe and to build an observatory in the vicinity of the town (1768), equipped with the best instruments that could be procured. In 1761 he observed the transit of Venus over the sun, and in 1769 he was visited for the same purpose by DE BOUGAINVILLE and VERRON from Paris and by COOK and GREEN from England; this observation failed, however, owing to clouds. With remarkable precision, taking the time in which he lived into consideration, he also determined the latitude and the longitude of his observatory. Some years after his death his house with the observatory was sold and pulled down afterwards. The spot where this first East Indian observatory stood and part of its foundations can still be seen, where, in the neighbourhood of the old town the kampong Klinting, a populous suburb, is situated now.

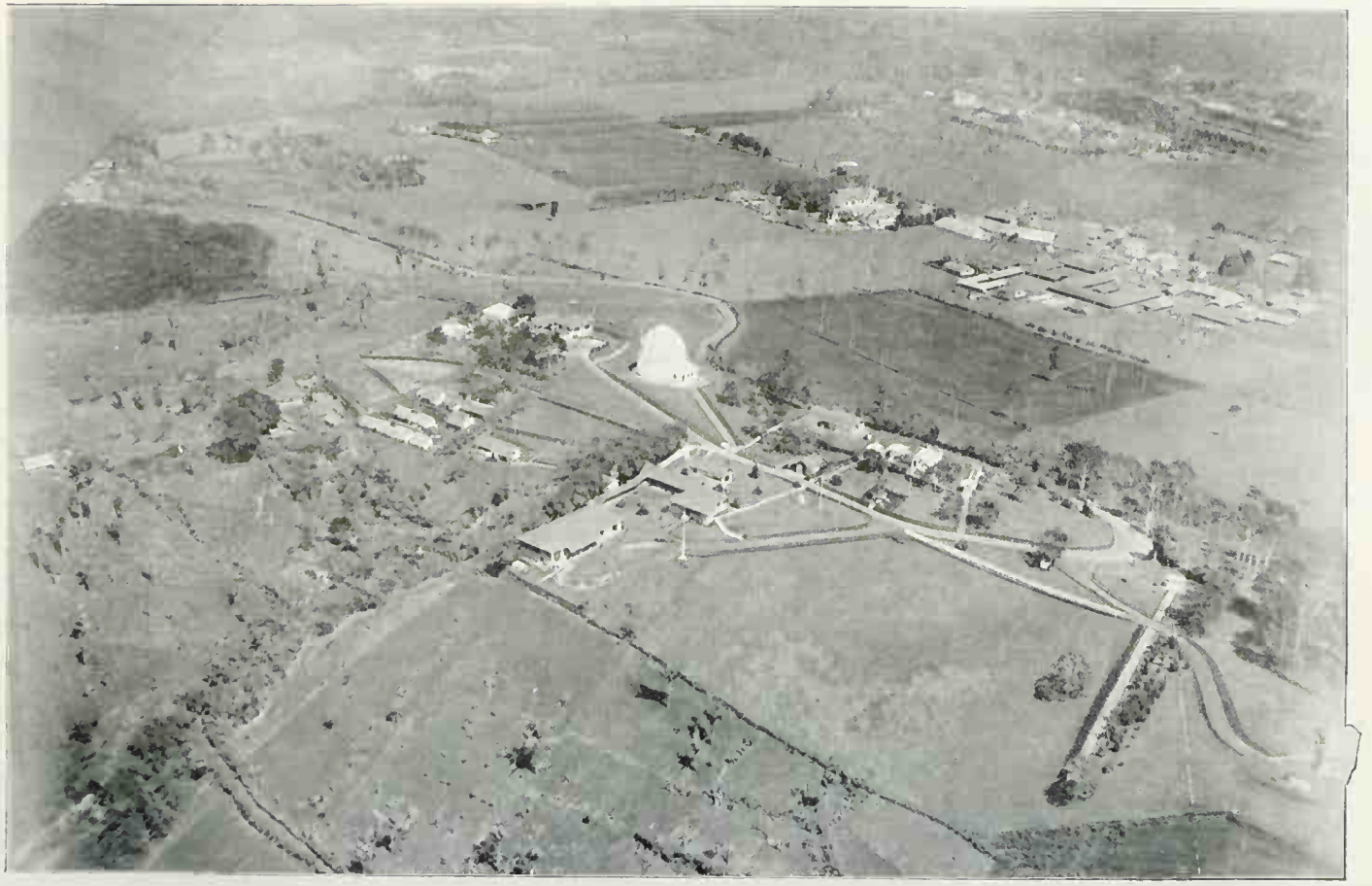
In the second half of the 19th century astronomical observations were again made, not for their own sake but for geographical purposes. Convinced of the necessity of having good charts of the Indian Archipelago and its chief island of Java the Government in 1857 appointed a young astronomer, Dr. J. A. C. OUDEMANS (then and afterwards again director of the Utrecht observatory) chief of the Geographical Service. During his 18 years' residence in the East Indies OUDEMANS and his assistants completed a triangulation of Java, afterwards published in 6 volumes, and ascertained the latitude and longitude of a great number of coast- and island points (by means of telegraphy and by the occultations of stars). He also found time to pay attention to other astronomical objects;

in 1867—68 he observed minima of the Algol variable $\delta$ Librae, and he also observed the total solar eclipses of Aug. 18th 1868 and Dec. 12th 1871.

After his departure in 1875 astronomy was only heard of in these islands when astronomers and astrophysicists from all countries came to the East Indies for the observation of a total solar eclipse. This was the case when the eclipse of May 18th 1901 was observed at Padang and the Padang Highlands by a number of expeditions. And Sumatra was visited again by parties from America, England, Germany and Holland on the occasion of the eclipse of Jan. 14th 1926. But at this time they found the conditions for astronomy changed; it had now found a permanent home here.

The real history of astronomy in the Dutch Indies may be said to have begun with the foundation of the Bosscha observatory at Lembang. This observatory is not an institution of the Government; it was founded entirely by private initiative and private means. Its founder was Mr. K. A. R. Bosscha, to whom science in the East Indies is greatly indebted also in other ways, assisted chiefly by Mr. R. A. Kerkhoven, an amateur astronomer himself. Mr. Bosscha had for years had the plan to erect an astronomical observatory, but he waited till he met the astronomer who could put his ideas into practice. He found the right man in Dr. J. G. E. G. Voûte, who had studied astronomy at Leyden, and who had there and afterwards at the Cape of Good Hope done valuable work in measuring double stars and star parallaxes. Having been placed as an assistant at the Meteorological Institute at Weltevreden, he tried to organize a section for astronomy there; having failed in these efforts he came into contact with Mr. Bosscha, and from this moment the organisation of the astronomical observatory for the Indies was their joint work. A number of prominent financiers and scientists were brought together, and in 1920 the „Nederlandsch Indische Sterrekundige Vereeniging" (Astronomical Society of the Dutch East Indies), the Board of the new institute was founded. Mr. Bosscha found the means for a large refractor with dome. Afterwards, in 1927, when the greater part of the observatory was completed and observations had already begun, a yearly government grant was obtained to cover the expenses for salaries and publications.

The place of the observatory was chosen on the northern slope of the large plateau of Bandung, on a hill to the S. of the village of Lembang, latitude 6° 49′ 29″ S, longitude 7h 10m 28s E of Greenwich, at a height of 1300 M above the sea level. To the South this place overlooks the plain of Bandung, 600 M below; and behind it is the Malabar, with its famous radio station, with Papandajan and Tjikorai to the left, Patuha and other mountains to the right. To the W. are the Buitenzorg mountains



The Bosscha Observatory at Lembang. General vieuw.
(Photo taken from a military aeroplane).

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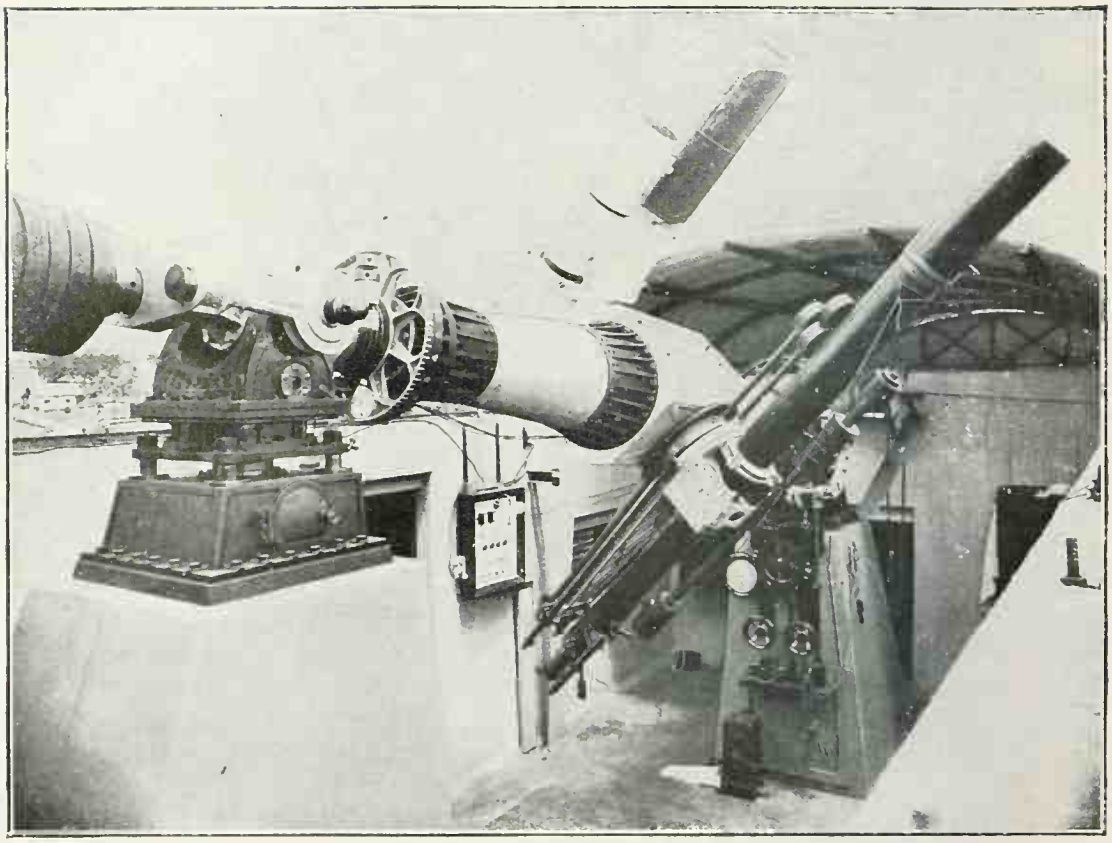
Gedeh and Pangerango, to the N. behind the village of Lembang the slopes of Tangkuban Prahu, a volcano, rise up. The buildings which contain the instruments are spread over an undulating extent of ground of nearly 5 ha. On the highest top the dome for the large refractor has been erected, which strikes the eye of the visiter already when he is at Bandung; the other instruments are in low buildings of which the roof can be rolled away.

The chief instrument of the observatory is the Bosscha refractor, which is in reality a double refractor with two objectives, a photographic and a visual one, both of 60 cm. aperture and 10.50 m. focal distance. In order to ensure a rigid connection, which is necessary when one objective is used to follow the star which is photographed by the other, they have been fixed together in one tube elliptical in section. A special construction is necessary because in this damp climate water is often condensed upon the lenses; hence there is a great distance between the crown and flint lenses, so that they may be easily cleaned on the inside. The instrument has an English mounting; the almost horizontal polar axis rests at both sides on heavy pillars. The floor, which has a diameter of 11.10 m. and a weight of 13 tons, can be raised and lowered by electricity. The iron dome, too, which has a diameter of 14.95 m. and a weight of 45 tons, can be moved in the same way. Refractor and dome were both constructed by the Carl Zeiss works at Jena; the refractor was mounted in 1928; the dome had already been finished at an earlier date.

The main purpose for which this large refractor has been constructed is the determination of parallaxes of southern stars. During the last decades parallaxes of hundreds of northern stars have been determined photographically with great precision by the collaboration of several American and European observatories (Yale, Sproul, Mc Cormick, Allegheny, Yerkes, Mount Wilson, Greenwich). The incompleteness of these data owing to the absence of the southern stars could only be remedied by the erection of refractors of the same size at southern observatories. In the second place this instrument will be used for measures of close southern binary stars. Though at practically the same time other large refractors were mounted at southern observatories, their number is so small as yet, that there will be plenty of work for each of them in this domain of astronomical research, as well as in others.

Among the smaller instruments of the Lembang observatory the most important is the visual-photographic combination in the eastmost building. A visual refractor and two photographic instruments have been fixed here on a heavy polar axis. The first (aperture 19 cm, focal distance 3 m) was constructed by Merz (1860) for the Leyden observatory; it was used by Kaiser for his measures of double stars and planetary



Te Bosscha Observatory at Lembang.
Merz refractor, triplet camera and Tessar in the East Building.

diameters and for his observations of the markings of Mars, but was replaced by a larger CLARK refractor in 1885. It is now made use of once more at Lembang and has been fitted with a new filar micrometer made by BAMBERG. Since 1924 Dr. VOÛTE has constantly used it for measures of southern double stars. Of the photographic instruments one is a camera with a ZEISS UV triplet (aperture 15cm, focal distance 1.50 m.) of the same construction as the instrument at Potsdam, the other is a camera with ZEISS tessar with an aperture of 12 cm and a focal distance of 60 cm. From 1925 to 1927 they were used for photographic measures of the light variation of southern Cepheid variables by means of focal and extrafocal exposures, in the latter case a coarse grating served to determine the photometric scale. An objective prism may be placed before the triplet to photograph stellar spectra. In this way Dr. P. TEN BRUGGENCATE took spectra of the bright southern stars, 1927 and 1928, in order to complete the Göttingen researches on the intensity distribution in stellar spectra.

Among the other instruments a SECRETAN refractor (ap. 16 cm) may be mentioned, which was offered to the observatory by the heirs of a Chinese amateur astronomer, Mr. SIM HONG LIE; on the same axis a DALLMEYER photoheliograph, belonging to TEYLER's Foundation at Harlem, is mounted. A ZEISS cometseeker (ap. 11 cm, foc. 76 cm) was used by Mr. MEESTERS, a former assistant, and is now made use of by Mr. WITLOX, assistant at the observatory, for the observation of long period telescopic southern variables. Some smaller cameras with lenses of angular apertures 1 : 3.5 and 1 : 2.8 are used to make extrafocal pictures of the Milky Way. The observatory possesses a large stereocomparator, constructed by ZEISS, for the measurement of the parallax plates. This has been specially constructed to measure the relative coordinates on two plates with the greatest precision, but allows also precise measurement of separate plates. For the reduction of the extrafocal images of the variable stars a HARTMANN microphotometer is used, by means of which the blackness of the silver deposit is measured; an instrument for the photo-electrical measurement of star images on a photographic plate will be added.

The Lembang observatory has also become a central point for the astronomic-geodetic work in the East Indies. Regular observations of time are made here by the engineers of the Topographic Service; for this purpose a BAMBERG transit instrument with travelling wire has been mounted, with a mire 97 m distant south; a HILDEBRAND theodolite is used for latitude determinations. Preparations are made to establish a branch of the Mizusawa international latitude station at Lembang, in order to make regular observations of the variations of latitude.

Several publications of the Lembang Observatory have appeared already, all of them bearing witness of the indefatigable zeal of the director, whose aim was not only to build an observatory but also to make a regular series of observations from the very beginning, with the instruments available. Two parts of Vol I of the "Annalen van de Bosscha-Sterrewacht" with measures of double stars have been published; also a part of Vol II, an exact determination and a discussion of the photographic lightcurves of some southern variable stars. Dr. Voûte has published a new edition of his Catalogue of Radial Velocities, which forms a part of Vol III. Other publications are in preparation. Two young astronomers have been added to the staff of the observatory. A legacy has been left to the observatory destined to extend hospitality as "research associates" to astronomers from Europe or America, who wish to execute or to complete a special program of research, for which observations of the southern sky are necessary. Thus judging from what has been performed or prepared during the short period of its existence the Bosscha Observatory bids fair to develop into an important centre of scientific research in the East Indies.

# ZOOLOGY AND ZOOGEOGRAPHY

by Dr. L. F. DE BEAUFORT,
*Director of the Zoological Museum at Amsterdam.*

It is no wonder, that the Indo-Australian Archipelago has always attracted zoologists, for here a number of islands with a rich and varied fauna are separated by seas, which are partly shallow, partly very deep and inhabited by a marine fauna of equal richness.

From a zoogeographical point of view there is hardly any place in the world of greater interest than this chain of islands between the Asiatic and the Australian continent.

In the west, the Greater Sunda islands, situated on a common continental shelf, have a fauna very similar to that of Malacca; in the east New Guinea and neighbouring islands, connected with Australia by the Sahulshelf, show the same affinity in their fauna with that of the tropical part of the Australian continent and between those two the islands of the Moluccas, often separated by very deep seas, have an animal life which shows a remarkable and puzzling mixture of Asiatic and Australian affinity.

Every zoologist, who has visited these islands, has been impressed by the facts just mentioned. When the great naturalist A. R. WALLACE visited the archipelago, where he spent eight years studying and collecting the fauna, he was so struck by the affinities of the fauna of these islands, whilst at the same time each of them has its own peculiar species, differing slightly from the neighbouring ones, that his thoughts were continually at work to find an explanation. From Serawak he wrote his first contribution to the question of the origin of species and later on, when in the island of Ternate, the principle of the survival of the fittest occurred to him and this made him write a paper at once, which he sent to DARWIN. The rest of the story is well known; DARWIN found his own ideas, which he had never published, expressed in WALLACE's paper. It stimulated him to publish his views, a joint paper by DARWIN and WALLACE was read at a meeting of the Linnean Society of London and caused great excitement: it was the birth of the evolution-theory, which has completely revolutionized biological

science. We can therefore say without exaggeration, that the biologist in the Indo-Australian Archipelago is on classic ground. If it is too much to say, that the evolution-theory was born there, one of the branches of this mighty stem, viz. genetic zoogeography, certainly sprouted in the Indo-Australian Archipelago, of which DARWIN wrote to WALLACE: "I think that the most interesting quarter of the globe in respect of distribution".

Most zoological work done in the Indo-Australian Archipelago is of zoogeographical nature. The example set by WALLACE, his masterly way of explaining his views on the distribution of animals, attracted many other zoologists and the problems here are so intricate and so complex, that even now it is a fruitful field for investigations of a most fascinating nature. Naturalists from all parts of the world, have gone to these islands to study the fauna. It would be beyond the scope of this book to give a historical account of the zoological discoveries, made here. Those interested in these questions, may be referred to a booklet, "The zoology of the Indoaustralian Archipelago", issued by the I. C. O. Committee in 1923.

The fauna of Java is better known than that of the other islands, but it is decidedly less rich than that of Borneo and Sumatra. This may be partly due to the fact, that a great part of the island is cultivated. The original fauna, and especially that of the virgin forest, is therefore now restricted to what has remained of the immense forests, which must formerly have covered a great part of the island. Some of the species only adopted themselves to a life in the open. A vivid account, of how cultivation has changed the aspect of the fauna is given by KONINGSBERGER in his book: "Java zoölogisch en biologisch". The fauna is here treated from an ecological point of view, that of the different biocoenoses: the woods, the fields, the hills and mountains, streams and lakes etc. are treated in succession and their characteristic forms of life are described. The book gives a comprehensive account of the javanese fauna but does not aim at being a complete faunistical work. Such a work, though wanted badly, is still lacking. Some classes of animals, however, have been treated exhaustively. Prof. M. TREUB, the late director of 's Lands Plantentuin at Buitenzorg, promoted the publication of a work on the fishes of the Indo-Australian Archipelago. This work, by M. WEBER and DE BEAUFORT, is still in progress, four volumes having appeared up to now, the first of which is a complete bibliography and an index to the works of P. BLEEKER, the celebrated ichthyologist, and pioneer on ichthyological work in the archipelago. In the same series two volumes on reptiles by NELLY DE ROOY have been issued and one volume on Amphibians by VAN KAMPEN.

It is to be hoped, that similar volumes on the higher vertebrates will be published before long. The material for such a work, especially with regard to birds, has been collected, but the literature is scattered in many periodicals. Of course the avifauna of all the islands is not completely known and many discoveries will certainly still be made, but for all the time is ripe for such a work. We possess some splendid monographs, it is true, on the avifauna of some of the islands. The birds of Celebes have been treated by A. B. MEYER and WIGLESWORTH in two volumes: "The Birds of Celebes", which are mainly based on the collections of the SARASIN's, who were the first to penetrate into the interior of the island. Well known is also the magnificent work by SALVADORI: "Ornitologia della Papuasia e delle Molucche". Both works however are out of date. Much indeed has been done since their appearance.

Our knowledge of the birds of New Guinea has greatly increased since the island has been made more accessible through the Dutch scientific and military explorations and the same may be said of the Moluccas. Many of the smaller islands have been visited by naturalists, who collected for the Tring Museum, such as KÜHN, DOHERTY, DUMAS and others. Many papers on the ornithology of different islands in the eastern part of the archipelago by ROTHSCHILD, HARTERT and STRESEMANN have been published in Novitates Zoologicae, the periodical of the Tring Museum.

VAN DEDEM's collections from Ceram and other islands have been studied by VAN OORT; and STRESEMANN, who collected there himself, has given us an account of the avifauna of this island. Quite recently a German expedition visited some of the Lesser Sunda-islands and several new forms have been described by RENSCH. The avifauna of Bali had previously been studied by STRESEMANN.

The monographs by MEYER and WIGLESWORTH and by SALVADORI are now antiquated. Not only because so many new discoveries have been made, but also because our views on the value of species and subspecies or geographical forms have changed so much since the publication of these works, that they would look quite different, had they to be rewritten now.

The avifauna of the Greater Sunda islands is also much better known, than twenty years ago. The only comprehensive work on the birds of Java is that by KONINGSBERGER: "De Vogels van Java", but this, too, belongs to a former period. In this island it is principally M. BARTELS who has made and is still making large collections and who has added much to our knowledge of the avifauna of this island, but many of his observations are as yet unpublished. The greatest advance perhaps has been made in our knowledge of the avifauna of Sumatra,

through the collections of DE BUSSY, VAN HEYST, VAN HEURN, JACOBSON, BODEN KLOSS, ROBINSON and others. The two last named ornithologists have amongst other things published a list of all species of birds, known to inhabit this island.

The literature on mammals is even more scattered than that on birds. Years ago TJEENK WILLINK published a list, but since then our knowledge of this class has never been reviewed. Yet much and important work has been done. Besides that of a more remote period, such as that done by M. WEBER, whose anatomical studies on mammals of these islands (as e.g. that on *Manis*) are almost classical, much systematic work has been done by JENTINK, on material in the museum at Leyden; by MILLER, LYON and others in te U. S. who studied collections made for the American museums and especially by OLDFIELD THOMAS, who wrote numerous smaller and larger papers on Indo-Australian mammals. As we mentioned above, the Greater Sunda-islands especially are rich in mammals. Those of Sumatra, Borneo and the smaller islands, such as those of the Riouw archipelago have been studied especially by Americans. The fauna of the interesting islands along the westcoast of Sumatra has also been collected by an American, ABBOTT. Some of the islands have formerly been visited by MODIGLIANI and the mammological results were published by OLDFIELD THOMAS. JACOBSON made extensive collections in the island of Simalur and the Mentawei-islands were revisited by BODEN KLOSS.

As has been mentioned above, the species of mammals inhabiting the islands to the east of the Greater Sunda islands are not numerous. The collections made by TOXOPEUS in Buru and those made by collectors of the Zoological Museum of Buitenzorg have been worked out by OLDFIELD THOMAS, who has also described many forms from other sources, amongst which *Rhynchomeles prattorum*, an endemic species of a new genus of marsupials from Ceram may be specially mentioned.

The mammalian fauna of New Guinea again is of greater interest. The few species of the monotreme genus *Zaglossus* are still imperfectly known. A survey of this genus has been given by KERBERT, the late director of the Zoological Gardens of Amsterdam, who gave some biological facts about these curious animals, specimens of which he studied in the Amsterdam Zoo. OLDFIELD THOMAS and ROTHSCHILD have more recently studied the same genus. The former also described many marsupials from this island, partly belonging to the collections of the British Museum, but recently also from those of the Zoological museum at Buitenzorg, where extensive collections arrived from the last Dutch New Guinea expeditions to the Mamberamo river and the central mountains. Those of former Dutch expeditions have

been studied by JENTINK, who also published a list of the mammals, then known to live in this big island. It is a well known fact that New Guinea is inhabited, not only by Monotremata and Marsupials, but also by many curious rats of Australian affinity, which have related forms in the mountains of Luzon in the Philippines, as was long ago shown by OLDFIELD THOMAS, who is certainly the best authority on these rodents, and whose publications on this difficult group are numerous.

New Guinea, especially its interior, has long remained unknown. In 1902 a first Dutch scientific expedition was sent out; others fol-

Part of laboratory for marine investigation Batavia.

lowed and slowly but surely the white spots on the map disappeared. Large collections have been made, and the results published in "Nova Guinea", a work of which Vols V, IX and XIII are entirely devoted to Zoology, whilst a new zoological volume is now being published. Besides these Dutch expeditions two British expeditions explored the Dutch part of the island. Several Dutch military surveys have made the interior of New Guinea more accessible and some naturalists, among whom was MEEK (who collected for the Tring Museum), have availed themselves of this opportunity.

The fauna of the central mountains, partly snow-clad, yielded many new species as might be expected, but we may safely say, that much still remains to be discovered.

From a zoogeographical as well as from an economical point of view the freshwater fish fauna of the Indo-Australian archipelago is of great

importance, at least that of its western part. BLEEKER has already made us acquainted with a great number of species from the Greater Sunda islands, but much has been added to our knowledge since.

The Dutch Borneo expeditions at the end of last century made extensive ichthyological collections (which have been studied by VAILLANT and Miss POPTA) and greatly increased our knowledge of the fishfauna of this island. WEBER and DE BEAUFORT described several new species from Sumatra. We may say, that the ichthyological fauna of these islands, as well as of Java, is fairly well known. As in the case of mammals the distribution of the true freshwaterfishes shows the great affinity between the islands on the Sunda shelf inter se and with Malacca. Most families do not reach farther east than here; Celebes f. i. being totally deprived of Cyprinoidea, which are still abundant in Borneo. The difference between the fauna of these islands is striking and the Straits of Macassar are an important zoogeographical boundary. This part of the much discussed "line of WALLACE" has certainly *raison d'être*, as has been pointed out by the SARASIN's. The southern part, however, between Bali and Lombok, has not the same significance. Cyprinoidea do occur not only in Lombok, but even more to the east in Sumbawa, and the distribution of other animals, too, shows that the contrast which in WALLACE's opinion existed between the fauna of Bali and that of Lombok, is not so important as he thought.

An interesting study on the fishfauna of Borneo and Sumatra was made by M. WEBER. According to MOLENGRAAFF the sealevel was so much lowered during the pleistocene ice-age, that the sea between Borneo and Java was transformed into a low land, where the streams of East Sumatra and West Borneo formed a large river, discharging itself into the South Chinese sea. If MOLENGRAAFF's views are right, the fauna of the rivers of East Sumatra and West Borneo must have mixed in pleistocene times. WEBER's object was now to investigate, if traces of these former conditions could be found in the recent fauna. He therefore compared the fishfauna of the river Kapuas of West Borneo, running into the Sunda sea with that of the river Mahakam of East Borneo, which discharges itself into the Straits of Makassar. The result was, that out of the 142 species, which are known tot exist in these rivers, only 52 occur in both. The Kapuas has 67 species, which do not live in the Mahakam and 75 % of these are also found in rivers of East Sumatra. In accordance with what MOLENGRAAFF's views might lead us to expect, this shows that the Kapuas has more affinity in its ichthyological fauna with the rivers of East Sumatra than with those of West Borneo. The Mahakam on the other hand, shows a great deal of endemism as a sign of its longer isolation.

The importance of the freshwaterfauna for genetic zoogeography is clearly demonstrated by this example. Formerly it was often believed, that the freshwaterfauna in the tropics did not show much variation. Although GÜNTHER, VON MARTENS and others had already developed different views, it was especially M. WEBER who pointed out its importance, in connection with his own investigations on the freshwater fauna of Sumatra, Java, Celebes and the Lesser Sunda islands.

Special attention was therefore paid to this part of the fauna during the Dutch New Guinea expeditions. The results were, with respect to fishes, that the typical freshwaterfishes which we meet in the western part of the archipelago, do not occur here. This might be expected, as they are not found in the Moluccas either. The rivers and lakes of New Guinea are inhabited by marine immigrants, which we find elsewhere too, but also by others, which have Australian affinity. Among these may be mentioned *Scleropages leichhardti*, some silurids of the family *Plotosidae* and aberrant *Atherinidae*. Last named, although immigrants from the sea, live now exclusively in fresh or perhaps somewhat brackish water. These *Melanotaeniinae* are not only known to occur in Australia and New Guinea, but have also been found in the Aru-islands and in Waigeu, both on the Sahul shelf.

Speaking about the freshwaterfauna of New Guinea, we may as well remember the turtles living here; some of them as *Emydura* show Australian affinity, others, such as *Carettochelys*, are relicts. This last-named genus was only imperfectly known, but during a Dutch expedition to the snowmountains LORENTZ and VAN NOUHUYS were able to secure a number of these creatures. WALTHER and VERSLUYS therefore had an opportunity to study their anatomy and came to the remarkable conclusion, that *Carettochelys* is closely allied to, if not congeneric with the tertiary *Anosteira*. LORENTZ and VAN NOUHUYS brought home from the same locality a large series of *Kurtus gulliveri*, a fish, in which the male has a curious hook on the head. It was not known whether this hook was of any use, but the two explorers just mentioned had the good luck to catch one specimen, which carried strings of eggs in this hook, as has been described in detail by M. WEBER. A unique example of parental care among fishes.

The freshwaterfishfauna of the Moluccas is very poor, that of Celebes also lacks the typical western forms, as has been mentioned above, but it has some remarkable species. The fish of Celebes have been studied by WEBER and afterwards by BOULENGER and Miss POPTA from collections made by the SARASIN's. They were the first to collect in the great central lakes of that island. Afterwards the missionaries KRUYT and ADRIANI as wel as the geologist ABENDANON had an opportunity

to collect there. This material has been studied by M. WEBER. In the lakes occur some species of silversides, forming an endemic genus *Telmatherina* and showing some resemblance to the *Melanotaeniinae*, without, however, being closely related, it would seem. These lakes are also inhabited by very aberrant *Cyprinodontidae*, thus showing that the unexpected and more or less alien element, that we find in other groups of animals in Celebes, is not absent in the fishfauna.

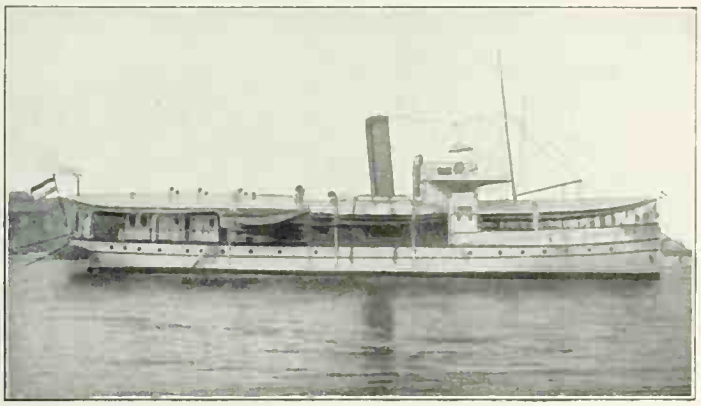
None of these forms have been found outside Celebes up to now. They may occur in the Moluccas where the freshwaterfauna is less well known. Here KÜKENTHAL made collections in Halmahera, TOXOPEUS in Buru, MERTON and ROUX in the Aru and Kei islands, and smaller collections from different islands have been made by other naturalists.

Of all groups that compose the freswaterfauna, the freshwatermolluscs have perhaps most completely been collected, but here too there are still gaps in our knowledge. We have just mentioned the fish of the lakes of Central Celebes. The SARASIN's discoverd here some species of basommatophore pulmonates with primitive characters for which they created the genera *Miratesta* and *Protancylus*. A second species of *Miratesta* was found later in the island of Obi, and this made me suppose above, that perhaps some of the peculiar species of fish of the lakes of Celebes may still be found in the Moluccas. *Miratesta*, however, has not been found in the large Lake Rawah in Buru, where TOXOPEUS made extensive collections. The results of this expedition, are now being published in the periodical of the Zoological Museum of Buitenzorg „*Treubia*" and an interesting report on molluscs has been given by Miss VAN BENTHEM JUTTING. MERTON and ROUX did not find *Miratesta* in the Kei and Aru islands nor did KÜKENTHAL in Halmahera.

The freshwatermolluscs of the Greater Sunda islands have been collected better than those of the Moluccas, as might be expected. It would take to much space to enumerate the different collectors or the authors who have contributed to the knowledge of the malacological fauna of these islands. A zoogeographical fact of importance is the occurrence here of freswatermussels of the family *Najidae*, which are related to South Asiatic species. They do not occur farther east; no members of this family have been found in Celebes, in the Lesser Sunda islands or in the Moluccas. *Najidae* reoccur, however in New Guinea and in some of the small islands on the Sahul shelf, e.g. on Misool, but all these species are quite different from those of the Greater Sunda islands and are related to Australian ones, as was pointed out lately by HAAS. Numerous are the publications on freshwater crustaceans. We wish to draw special attention to the careful studies by DE MAN, besides those by ROUX and M. WEBER. Of special interest is the occurrence of

crayfishes in New Guinea, the Aru islands and Misool, whereas they are absent from the other islands of the archipelago. They belong to the family of *Parastacidae* and are near relatives of Australian species, as might be expected.

The lower freshwater evertebrate fauna has also attracted attention. M. WEBER described freshwatersponges from Sumatra and Java and lately Miss VORSTMAN has made investigations on the fresh water sponges and Bryozoa of Java. MENZEL published valuable contributions to the knowledge of the microfauna. Besides these studies of a purely scientific character many investigations have been made for practical



The exploring vessel Brak.

purposes, f. i. those on the distribution of mosquito-larvae in connection with malaria. It suffices here to remember the work of SWELLENGREBEL and Mrs. SWELLENGREBEL-DE GRAAF, of different members of the staff of the Burgerlijke Geneeskundige Dienst (Civil medical service) and that of SUNIER, whose study is perhaps the most important from a zoological point of view. SUNIER studied the fauna, and especially the mosquito-larvae of the ponds, where the bandeng (*Chanos chanos*) is bred. This fish is is highly esteemed as food and is kept in large ponds of brackish water principally along the north coast of Java and Madura, where hundreds of acres are covered with them. The fry is caught by special methods at sea and taken to the ponds.

It is easy to understand, that these enormous stretches of water also form excellent breeding places for mosquitoes, at least for those species, the larvae of which can stand a certain salinity.

The above-mentioned study by SUNIER was chiefly devoted to the occurrence of these insects, but his work is of a much wider scope.

as he also investigated the fauna of other ponds and lakes in Java as well as in Sumatra.

Landshells with butterflies, beetles and birds belong to the group of animals, which have been most extensively collected everywhere and those of the Indo-Australian archipelago are no exception; on the contrary, they have long drawn the attention of private and museum-collectors. It is therefore impossible to give a survey of our knowledge of these animals in a book like this and we must confine ourselves to some isolated facts. We have no monographs on landshells of the archipelago, as a whole. Those of Celebes have been studied by the SARASIN's and the results have been published in a splendid work, which at the same time formed the base for their zoogeographical studies of that island, which we have mentioned already. An account of the malacological fauna of New Guinea has been given by TAPPARONE CANEFRI, but since then our knowledge has become much more extensive. Many contributions to the fauna of different islands have been published, some of them containing complete lists of the species known. Lately Miss VAN BENTHEM JUTTING gave an account of those of Buru, based on the material collected there by TOXOPEUS.

It would be an enormous task to give a survey of all entomological studies about the Indo-Australian archipelago. Since the beginning of last century entomological collections have been sent to European museums, especially to the Leyden Museum. Afterwards WALLACE sent his extensive collections from all parts of the archipelago to England and many others found their way to other museums and private collections. Literature on this group is therefore scattered in many publications, such as in those of the Leyden Museum, in the journal of the Dutch entomological society, in the Novitates Zoologicae of the Tring Museum, which sent out several special collectors. Lately the zoological Museum at Buitenzorg also sent out collectors or smaller expeditions to different islands, and much work has been done by KARNY, the entomologist of this museum, especially on *Gryllacridae*. It is impossible to give the names even of those, whose entomological work is well known; therefore for fear of doing injustice to many who certainly deserve to be mentioned in these pages, I shall confine myself to call attension to a few works. As far as butterflies are concerned one of the volumes of the great work by SEITZ is devoted to those of the Indo Australian region; PIEPERS and SNELLEN in collaboration with FRUHSTORFER have published a monograph on the Rhopalocera of Java, which through the death of the authors has never been completed.

As far as I know, there are no monographs of other orders of insects, but only of smaller groups, e.g. of some families of Papuan Coleoptera

in Nova Guinea. The splendid monograph by BETREM on the *Scoliidae* may be mentioned here too.

So far I have only spoken of purely scientific entomology, but the amount of work done in economical entomology is also very large and of great importance. The insectpests of the most important cultivations, such as rice, tobacco, sugar-cane etc. have been studied at the different experimental stations in Java and Sumatra. This work, done for practical purposes need not be treated in detail, but we must not omit to say, that the zoologists, attached to the stations just mentioned, have done much work in a more faunistic line, in addition to that of direct practical importance. In this way the knowledge of local faunas has been promoted in no small way. At the experimental station in Deli (Deli-proefstation) DE BUSSY, the former director, made large collections and founded a zoological museum. His work is now continued by VAN DER MEER MOHR, who with FULMEK even started a periodical of their own, in which many papers on the fauna of East Sumatra and of some small islands in the neighbourhood have been published.

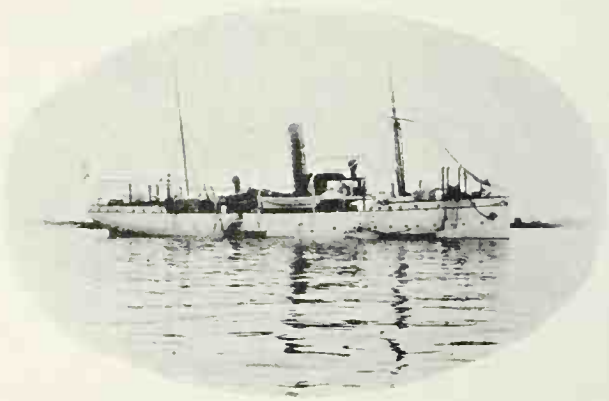
Practical entomological studies have been published in the different publications of the experimental stations, but comprehensive works have also appeared, e.g. one by ZEHNTER on the animals causing damage to the sugar cane, and the textbook on agricultural zoology by DAMMERMAN. Many of these entomological investigations are partly of a practical, partly of a purely scientific value, and several papers of this kind may be found in Treubia, the publication of the zoological Museum at Buitenzorg, e.g. studies by ROEPKE. We must not forget to mention the important work done by LEEFMANS and especially his oecological studies of different insects.

The zoological museum in Buitenzorg is still young — it was opened in 1901 — but it has done much to promote the knowledge of the fauna of the different islands in the archipelago. Several expeditions have been sent out by this museum. The director, Dr. DAMMERMAN, travelled in the island of Sumba; KARNY and SIEBERS in South Sumatra; the latter also in East Borneo and the Kei islands. A most interesting study, started by the zoological museum, is the investigation of the island of Krakatau.

In August 1883 this island, situated in Sunda Strait, between Java and Sumatra, suffered from a terrible eruption, volcanoes more than 400 m. high disappeared totally and another one, 800 m., was split and one half disappeared. Three islands remained, which were covered with a layer of hot ashes 30—60 m. high. It may be understood that but little of the original fauna was left. Many naturalists are of opinion, that life was totally destroyed, others suppose, that some animals

survived the catastrophe, as I will mention presently, but as DAMMERMAN puts it: "certainly 99 % of the animals living in the islands now are new invaders". It goes without saying, that here was an unique opportunity to study the way in which an island deprived almost if not entirely of animal life, is repopulated.

It is a pity that no thorough exploration of these islands has been made from the beginning. The first zoologists, that visited Krakatau after the eruption, could only study the litoral fauna and it was only 25 years after the disaster that the terrestrial fauna was collected



H. M. twin-screw Gun-boat "Siboga".

systematically. It is therefore impossible to say, in what sequence the animals now living there reached the islands.

DAMMERMAN, the director of the zoological museum, started a general zoological survey in 1919, and since then the islands have been visited more or less regularly by him and other zoologists. The results of these investigations have been published in "*Treubia*". Some facts may be briefly mentioned here.

No other mammals than rats, introduced by man, and bats have been found. Several species of birds inhabit the islands now and breed there. Few snakes and lizards have been met, amphibians are absent. Insects are rather numerous, but all entomological collections have not been studied as yet. It is noteworthy, that MICHAELSEN described an endemic earthworm which made him suppose, that this species escaped destruction during the eruption. Among landshells Miss VAN BENTHEM JUTTING also found a form which is not known to exist in any other place and SCHARFF has brought this forward as one of the arguments for his supposition that some animals found shelter under rocks and in this way escaped destruction. DAMMERMAN comes to the conclusion,

that for the repopulation dispersal through the air (actively or passive) is of greater importance than the part played in this process by the sea.

Now that the fauna has been inventarized, it is most important to study further development and how it will be added to by new-comers.

We must now direct our attention to the marine fauna, which has attracted naturalists ever since the time of RUMPHIUS. The most interesting fauna is to be found in the seas between the shallow Java- and Sahul-seas, where several basins of great depth occur, communicating by more or less shallow thresholds. Coral reefs are more numerous here than in the west and the littoral fauna is therefore much richer. Although many zoologists have been working here individually, it is especially since the Siboga expedition explored these waters, that the marine fauna of this part of the world has become known. The results of this expedition are remarkably rich. In many groups the number of species collected is greater than that of other expeditions which have worked over a much larger area. This may be partly due to the circumstance that here, within narrow limits very different conditions prevail, but certainly also to the zeal and energy of the scientific staff, under the leadership of M. WEBER. The results have been published in a series of volumes. Some groups have not yet been worked out.

The Siboga expedition for the first time has made us acquainted with a deep-sea fauna of the Indo-Australian archipelago, the Challenger expedition having only visited the extreme east and the Valdivia the extreme west of this region. Though much time was devoted to deep sea dredging, the collecting of the littoral and pelagic fauna was not neglected. How little the marine fauna of this part of the world was known before the Siboga explored it, may be gathered from the fact, that of almost all groups, whether coelenterates, echinoderms, vermes or others, generally one third and often even more consists of species hitherto unknown. Many of the authors who worked out the different groups, did not restrict their studies to the material collected, but have often revised the whole group or the species known to inhabit the Indo-Pacific. Many also have given anatomical details and made zoogeographical remarks which greatly add to the value of these publications.

Thanks to the Siboga expedition the marine fauna of the eastern part of the archipelago is now better known than that of most other tropical seas, although here too, further discoveries may be expected. The short visit of the "Albatross" to these waters in 1909 e.g. has made us acquainted with several new species of deep-sea fish, which had not been found by the Siboga. One of the remarkable discoveries of the Siboga was that of a region of medium depth near the Kei islands, which yielded a fauna which is generally only found at greater depths.

The "Siboga" at work with the dredge.

When therefore Dr. TH. MORTENSEN of Copenhagen planned the erection of a Scandinavian marine station in the archipelago, M. WEBER suggested the Kei islands. In collaboration with BOSCHMA, MORTENSEN made investigations on this spot and secured rich materials, which have been partly worked out already. Owing to lack of funds however, the plans for the station had to be relinquished.

Though at present there is no biological station in this part of the archipelago, there is one very well equipped in the western part, viz. at Batavia, with a good aquarium and every facility to workers, who want to study the marine fauna of the Java sea. This shallow sea however is less rich and certainly less varied in its fauna than the eastern seas, although even the fauna of coral islands can be studied at no great distance, viz. at the Duizend islands. Years ago SLUITER made important studies here on different marine animals, such as gephyreans, holo-

thurians and tunicates. He also studied the growth of corals on a muddy bottom and showed that, as their weight increases through growth, they gradually sink into the soft substrate and may in this way form coralbanks of considerable thickness. These investigations, however, date from a time, when the above mentioned station was not in existence. It was erected in connection with fisheries-investigations and the Government steamers "Gier" and "Brak" roamed all over the Java sea, collecting data and material of hydrographical as well as of zoological nature. The results of these trips and of the study of the collections made by the successive directors of the station VAN KAMPEN, SUNIER and DELSMAN, have been published in "*Treubia*" and in other periodicals.

DELSMAN lately started interesting investigations on fish eggs and larvae of the Java sea, a subject which has found but scant attention in the tropics up to now. Another important study of the same zoologist is that of the distribution of freshwater eels in Java.

These investigations were suggested by JOH. SCHMIDT, whose work on the Atlantic eels is celebrated. Lately SCHMIDT directed his attention to the Indo-Pacific eels. Things are much more complicated here than in the Atlantic, where only two species, the European and the American eel, spawn. SCHMIDT estimates the number of species of freshwatereels living in rivers which discharge into the Indic and Pacific at sixteen at least. A good many of these species live in the rivers and lakes of the Indo-Australian archipelago. There is no certainty yet about the place where they spawn. As far as the archipelago is concerned, *Leptocephalus*-larvae of *Anguilla* have only been found by the Albatross near North Celebes and one of the problems, yet unsolved, is to discover the breeding-places of the eels, not only of the archipelago, but of all regions bordering the Pacific and the Indic.

Now SCHMIDT drew attention to a phenomenon of importance. He pointed out, that as far as the available data prove, freshwatereels of the genus *Anguilla* are apparently absent from the Malay Peninsula, and in the rivers running into the Gulf of Siam. In Borneo, Java and Sumatra they occur only in the freshwater of the coasts facing the deep sea, but not in the rivers discharging into the shallow Java and Sunda seas. From these data, SCHMIDT drew the conclusion that the elvers of the eels living in the Greater Sunda islands cannot migrate through shallow water, like those of the Atlantic. DELSMAN now began an elaborate inquiry into the distribution of *Anguilla* in Java and the results he arrived at agreed in every respect with what SCHMIDT had deducted from the scanty material at his disposal. DELSMAN proved that in Java *Anguilla* lives only in the rivers discharging into the deep Indic in the south, in those running into Sunda Strait in the West and in those of the

extreme eastern part of the island, and that they are absent from all rivers the mouth of which can only be reached after a rather long journey in shallow water. DELSMAN supposes that the explanation of this phenomenon is to be found in the higher temperature of the water, as compared with that of the Atlantic, which accelerates the growth of the larvae and gives them no time to travel from the deep waters where they are hatched, to shallow seas.

This is only one side of the interesting problem, which we hope SCHMIDT will bring nearer to its solution on his next expedition in the "Dana". The new Dutch oceanographical expedition, which will explore nearly the same waters as those in which the Siboga worked, will possibly too help to solve the interesting problem of the breeding of the tropical freshwater eels.

# BOTANY.

## I. GENERAL BOTANY

by Dr. F. A. F. C. WENT,
*Professor of General Botany at the University of Utrecht.*

After its foundation in 1817 the Government Botanic Gardens ('s Lands Plantentuin) at Buitenzorg have become the centre of botanical study in the Netherlands East Indies. Besides, several institutions for applied research work have been established since 1886, some of which are found at Buitenzorg, but most of them elsewhere in Java and in Sumatra. In these institutions also botanical investigations are made and thus the sole ruling of the Buitenzorg Gardens has come to an end, though pure botany is almost exclusively studied there.

Taxonomic and geographic botany are a special feature of the work done at one division, the herbarium and will be discussed in the second part of this chapter. Of the other functionaries who study botany we must mention in the first place the director of the Garden (first REINWARDT, after him BLUME, next after a long interval SCHEFFER and MELCHIOR TREUB, who was succeeded by J. C. KONINGSBERGER, and since 1917 the present director W. DOCTERS VAN LEEUWEN) with his assistants and the director of the Treub-laboratory. One of these has also entrusted to his care the botanic laboratory in the mountain-garden of Tjibodas.

The botanic gardens themselves covering an area of 58 H.A. are for the greater part an arboretum, in which the trees have been arranged in accordance with the natural plant-system. Among other things the gardens also contain a garden for annuals and perennials and one for climbers; also the so-called forest-garden imitating as far as possible the conditions of a tropical primeval forest, so that in it numbers of forest plants can be studied in their natural surroundings. Besides these there are the lath-work conservatories where orchids, ferns etc. are grown. It is impossible to give a detailed description of these famous gardens in a few pages. For that matter every visitor can wander about them with the help of a guidebook, which is to be had in the gardens.

It will only be necessary to state that the gardens serve as a scientific institution in the first place, so that their external appearance has only been paid attention to so far as this is compatible with the requirements of science. Yet there are a good many spots famous for their beauty,

Alley of Canary-trees in the Botanic Garden, Buitenzorg.

such as the Avenue of Canarytrees, the large lake, the various ponds in the lower-lying parts of the gardens etc.

The great importance of the gardens is due to the systematic arrangement of plants mentioned above, which was carried through by the curator J. E. TEYSMANN at the advice of HASSKARL, and is not found on such a large scale in any other tropical botanic garden. The gardens owe their fame also to the excellent opportunities to study there, offered by the various laboratories, which are open to students from all countries.

Moreover, on the slope of Gedeh, a volcano, in the Preanger Regencies,

a branch establishment is found at a height of 1450 M. above the level of the sea. Here, at Tjibodas is a botanic garden of 31 H.A. on the boundary of a stupendous primeval forest extending as high up as the tops of Gedeh and Pangerango (at about 3000 M.). It covers an area of 280 H.A. and has been placed under the supervision of the director of the government botanic gardens as a natural monument. Tjibodas also boasts a well-appointed laboratory and accommodation for students wishing to stay there.

A few years ago another branch of the botanic gardens was established

Pond in the Botanic Garden Buitenzorg; early morning.

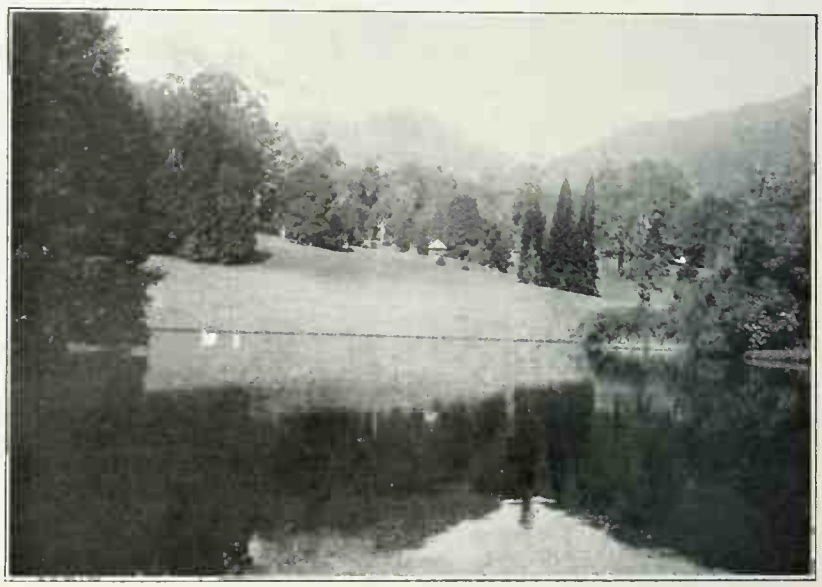
at the fisheries- experiment-station at Batavia. Mangroves and generally plants from the seashore are grown there under their normal conditions: it has also a laboratory for research work.

Investigators from every civilised country in the world have visited the government botanic gardens; among them — especially in pre-war days — there were many Germans and Austrians but in the first place of course also Dutchmen to whom the Buitenzorg endowment afforded an opportunity to visit the gardens with a fellowship. Similar endowments existed also in some other countries. It goes without saying that the war suddenly put an end to the visits of foreigners. But after peace had been concluded gradually the former condition was restored and at present

the gardens are once more visited by students from abroad though not in such great numbers as before 1914.

The consequence of all this has been that botanical research-work in the Netherlands East Indies has by no means been performed by Dutchmen exclusively and that the results of this work have been published in periodicals of the whole world. The greater part, however, is found in the garden's own periodical: the "Annales du Jardin Botanique de Buitenzorg".

The first part, edited by SCHEFFER, appeared in 1876; it contains



View in the Botanic Garden at Tjibodas.

only articles on taxonomics and plantgeography. As many as nine years afterwards the second part, edited by TREUB, appeared, but since then the periodical has appeared regularly; its contents cover the whole field of botany. With a few English periodicals it is at present no doubt the most important periodical for the knowledge of the botany of the tropics.

Other publications by the Government Botanic Gardens may be passed over in silence here because they deal either with practical problems or with taxonomic and floristic botany. Our space does not allow us to discuss the former, whilst the latter will be treated of in the next article

The results of research-work performed by foreigners are partly found in the Annales mentioned before, but also elsewhere; mention

must be made here of the "Botanische Mitteilungen aus den Tropen", edited by A. F. W. SCHIMPER. It would be utterly impossible to mention other periodicals in these pages.

It is conceivable that the first investigators of tropical plants confronted as they were by the stupendous variety of forms, occupied themselves at first with the establishment of order into chaos, so that for centuries their work was of a purely descriptive nature, also in

The TREUB-laboratory, with benches for visitors to the gardens.

the Netherlands East Indies. It may be said that only after 1880 the attention of research-workers was attracted by other things, especially by the relation between the structure of plants and the circumstances under which they live in the tropics. Of course it was only possible to study subjects of general botany after laboratories could be made use of and the work of investigators depended no longer on chance observations in the open air. Materials conserved in the Dutch East Indies have also very often been studied in Europe; for this work no laboratories at Buitenzorg were required. This was not the case with physiological and ecological researches, which can only be made on the

spot where the investigator has the necessary instruments at his disposal. As a rule these researches take up much time and it is a matter of course that those who visited the Indies only for a short time consequently were not always the right people for investigations of this kind. The result is that occasionally such researches are characterised by superficiality.

It need hardly be said that every botanist in the Netherlands East Indies will be struck first by the extremely luxuriant vegetation, especially as is most times the case, these investigators come from Europe or rather from countries belonging to the temperate zones. But in another respect yet, the plants of the tropics differ greatly from what is observed about those of Europe, North America and Japan. TREUB was the first to point out that the plants there all hibernate and that consequently the physiology of plants which is based on observations in Europe might be compared with a physiology of animals based on observations about marmots. There is some truth in this, though TREUB's statement is not without exaggeration. It is true that such a thing as a *winter*sleep is something unknown in the Indies, but for all that certain times of rest in the vegetation also occur there. Investigators have to a certain extent been led astray by the more or less exceptional climate of Buitenzorg. The foreigner visiting this place was apt to forget that in other parts of the archipelago the difference between a dry and a wet monsoon is much more striking than at Buitenzorg.

It goes without saying that it is impossible to give in these pages anything like a complete survey of what has been achieved in the field of general botany. It will only be possible to devote a few words to some of the most important things. For other subjects readers interested in these studies are referred to the periodicals mentioned above and to others as well.

It will be necessary to make a classification of the subject-matter (though I am well aware of the fact that any classification must of necessity be artificial) and therefore I intend to discuss first the results of what has been investigated in the field of morphology (including histology, cytology and embryology); after that the physiological researches (including genetics) and last of all to devote a few words to what has been done in the field of what is sometimes called biology in a narrower sense or what is at present also known by the name of ecology, i.e. the interaction between plants and their natural surroundings, both as regards anorganic nature and the living beings around them.

Morphological researches were first undertaken by MELCHIOR TREUB. When he was placed at the head of the Government Botanic Gardens, he understood at once that he had an excellent opportunity to study

numerous problems, which could be solved in the tropics only. The many Loranthaceae found there led him to minutely investigate the embryology of these plants; the same holds good also for some Cycads and for a few Orchids. But it was of far greater importance that TREUB succeeded in finding and developing the prothallia of some species of Javanese Lycopods. With the help of these he succeeded is building up a complete developmental history of these Pterydophyta. It should be borne in mind that

Professor M. TREUB in the old visitors' laboratory;
at the same bench more in the background,
Dr. S. H. KOORDERS.

at that time the result of BRUCHMANN's investigations had not yet been published and that generally speaking nothing was known about the development of the species of Lycopodium in Europe and North America.

Of no less importance were the researches after the development of the embryosac and the embryo of the Casuarinas, some species of which are found in great numbers in the Netherlands East Indies. On this occasion the phenomenon of chalazogamy was discovered, which as NAWASCHIN found out at a later date, occurs also among some European

plants. Afterwards TREUB made researches about the development of the embryosac and the embryo of Balanophora elongata. Though ERNST has proved that TREUB was the victim of deceptive circumstances when he assumed that the embryo originated from one of the cells of the endosperm, yet this investigation has yielded a great many valuable data about these strange phanerogamous plantparasites. LOTSY afterwards did state the correctness of TREUB's observations in his study of a few other Balanophoraceae.

Numerous other investigators have studied morphological problems though not on such a large scale as TREUB had done. Without attempting to give a complete list, I mention first and foremost GOEBEL, who studied mosses and liverworts, hundreds of which are found in the neighbourhood of Tjibodas especially; those who are familiar with those plants need only be reminded of Treubia insignis. But GOEBEL did far more. He studied ferns and Cyperaceae, Utricularias, and Sonneratias and his first stay in the Dutch East Indies also gave utterance to a part of his beautiful "Pflanzenbiologische Schilderungen". The result of his last visit to Java is embodied in numerous shorter articles but especially in the new edition of his "Organographie der Pflanzen".

Others who might be mentioned are e.g. SOLMS LAUBACH, who studied Rafflesias and Psilotum; G. KARSTEN, for his study of the development of Gnetum and also of the very curious Chroolepideae; KOORDERS, who made the development of the embryo and the embryosac of the teak, Tectona grandis, the subject of his investigations, K. WINKLER who investigated apogamy.

Investigations belonging to a more recent period are those by CAMPBELL and ERNST, on ferns and liverworts; SCHOUTE on the ramification of monocotyledons and ferns and the increase in diameter of the stems of some palms; ERNST and BERNARD on the morphology of many Phanerogamous saprophytes; COSTER on the formation of annual layers of wood in the tropics. Many more names might be added to this list, which even then would be far from being complete. Of all these I only wish to make mention of a series of publications by COSTERUS and J. J. SMITH on teratological phenomena in the Dutch East Indies.

Morphological researches have also been made elsewhere, especially for the purpose of acquiring a profound knowledge of various tropical cultivated plants. An admirable study of the external morphology of sugarcane has been made by JESWIET; its internal structure has been described among others by KOBUS. In various experiment-stations a number of investigators have carefully examined the structure of the laticiferous bark of Hevea brasiliensis; others have studied the morphology of rice, etc. Here, too, I must confine myself to a few examples

and now pass on to the discussion of those investigations that belong to the field of physiology.

Many of these could not possibly have been made elsewhere and we shall also see that many investigations, begun in Java, have led to further observations in other parts of the world. With respect to these I think of TREUB's investigations about the part played by HCN in plants. TREUB imagined that this HCN was the first product of the appropriation of nitrogen by the plant which ultimately leads to the formation of protein. The great quantities of hydrocyanic acid found in some tropical plants such as Pangium and Manihot utilissima led to these researches. It would seem that at present biologists are not much inclined to accept this hypothesis, but yet it has led to many investigations and to this very day nobody has been able to prove that TREUB was wrong.

More closely connected with the circumstances of life in Java were the investigations about phenomena which recur at regular intervals in plants. SCHIMPER's conclusion was that there is an internal periodicity, but this conclusion was based only on chance observations, as he had never made any experiments. KLEBS, however, experimented on a large scale in this field and his conclusion was that the regular sprouting of the buds depends very much on external conditions. It was especially his observations in Java which led him to this opinion. COSTER's investigations on the formation of annual rings may also be said to belong to this category. The curious periodic flowering of some plants such as Liberia coffee and a few Orchids drew the attention of several investigators. The most detailed examination was that of Dendrobium crumenatum. COSTER, the last of those who have devoted their time to the examination of this plant thought that not unlikely the buds of this Orchid which have reached a definite stage of development come to a standstill until a sudden fall of temperature acts as a stimulus to the full development so that they open after a few weeks. In the open air this fall of tempesature would be caused by heavy tropical showers.

Several economic plants in Java have been investigated as to their physiology; some of these researches gave results of more general importance; among other things the formation and accumulation of sucrose in sugarcane have been studied; worth mentioning, too, are the investigations about the formation and the function of latex in the bark of Hevea brasiliensis. It could hardly have been expected that such a difficult problem would have been solved for good and all, but however this may be, several investigators — among whom ARISZ and BOBILIOFF may be mentioned — have found many new facts. Most remarkable are BOBILIOFF's researches in which he succeeded in cultivating the latexcells

of Carica papaya in an artificial nutrient solution, which enabled him to study them in several respects.

The cultivation of varieties of Cinchona led to the studies of the origin and the accumulation of cinchona alkaloids; investigations have also been made on alkaloids in other plants, especially by WEEVERS on the part played by coffein and theobromin in plants.

Experiments on metabolism have been carried out by COSTERUS and by GILTAY. The latter has also studied evaporation, which had before him been done by HABERLANDT and by STAHL. The latter also made a more general study of the function of the leaves with regard to their shape and colour. WIESNER, among the many subjects studied by him, devoted his attention especially to the quantity of light which plants in the tropics have at their disposal. Others have studied the growth e.g. G. KRAUS, later BLAAUW of the aerial roots of Cissus; and J. KUYPER of the stems of sugarcane.

When G. HABERLANDT is mentioned a second time this is partly also on account of his studies of such hydathodes as consist of living cells; in this case, too, it was Buitenzorg which enabled him to discover this new organ in the vegetable kingdom. But HABERLANDT's work was not limited to these studies. His well-known book "Eine botanische Tropenreise" is almost especially a work on Java and more especially on Buitenzorg. It is worth reading by every botanist and gives a brilliant description of the conditions under which plants live in moist tropical regions and of the adaptations found among these plants. Those who have lived in Java during a longer period of time may here and there find something on which they do not agree with the author, but this can hardly be said to diminish the general value of the work. There have been more visitors who have tried to write works of this kind, but none of them have either surpassed or even equalled HABERLANDT. The work that resembles HABERLANDT's most is MASSART's "Un botaniste en Malaisie", whilst mention must also be made of a Dutch book, of a more or less different aim, viz.: to make the educated classes of society familiar with the peculiarities of the flora of Java and Sumatra: I mean BLAAUW's "De tropische natuur in schetsen en kleuren" (Sketches and colours of tropical nature).

A few words must still be said about genetic work. This has been done especially at the experiment-stations and hence was undertaken for practical purposes, thus sugarcane, tobacco, cinchona, coffee, rubber, oilpalm, rice, etc. were improved. The results obtained at these stations are often of general scientific importance, such as the selection of Cinchona varieties with a high percentage of alkaloids, the selection of Hevea brasiliensis and Elaeis guineensis and above all the study of sugarcane.

Among those who have studied this subject JESWIET must be mentioned first and foremost; BREMER deserved to be remembered for the cytology of the various bastards. Besides many of the results of the study of sugarcane have thrown light on the vexed question of degeneration, which was said to be a consequence of a continual vegetative propagation of plants. KNIEP has of late made observations at Buitenzorg about the sexuality of the higher fungi, about which, however, nothing has been published yet.

The discussion of the so-called degeneration has led us to a field which is not pure genetics, but does not entirely belong to physiology either and this brings us to those groups of investigations which refer to the circumstances under which plants live, especially with regard to their surroundings, to the domain sometimes called biology s.s. Strictly speaking it is not possible to draw the line between biology and physiology. Hence part of what is discussed here may not improbably be considered by others as belonging to the field of physiology.

The first observations that attract our attention are those about such groups of plants as are most conspicuous in the tropics of Asia, especially epiphytes and mangroveplants. SCHIMPER's best known investigations so far as the epiphytes are concerned were made in tropical America but he continued them in Java and the results are to be found in his "Pflanzengeographie", whilst others, such as G. KARSTEN have followed in his track. SCHIMPER's great work so far as the mangrove is concerned was done almost entirely in the Dutch East Indies and much of our knowledge is still based upon these observations, though it has become necessary to re-examine a few details, which has been proved especially by VON FABER's observations.

Special forms of climbers and epiphytes were studied by TREUB, among others; mention may be made here of hookclimbers and climbing-palms, the curious Dischidia Rafflesiana and the Myrmecodias. TREUB has proved that the canals in their tubers are not caused by ants, though these animals are always found in them. This subject has been studied more closely by MIEHE but it is especially DOCTERS VAN LEEUWEN who has of late years brought to light numerous new facts concerning the relation between ants and plants.

I must not omit to mention here that we are also indebted to the present director of the Government Botanic Gardens for an exhaustive study of all kinds of galls undertaken by him in collaboration with Mrs. J. DOCTERS VAN LEEUWEN—REYNVAAN. This stupendous work begun long before their residence at Buitenzorg is positively unique for the tropics and a monograph of this kind is something unknown even for many countries in the temperate zones.

Ants and plants in Java have been studied also in another respect. BURCK has studied the extranuptial nectaria. A more detailed and experimental study of this subject was made by Mrs. M. NIEUWENHUIS VON ÜXKÜLL—GÜLDENBANDT, who has proved that even in the country where he made his observations, BECCARI's ideas of myrmecophily are

Prof. E. STAHL in the Botanical Laboratory
at Buitenzorg; in the background
Prof. A. F. W. SCHIMPER.

practically untenable when they are made to stand the test of experimental investigation.

Observations on pollination by means of insects, kalongs and other animals have been made by a good many investigators in Java. It would lead me too far to mention the names of all of them in these pages. The only one of these investigators I think it incumbent upon me to mention is BURCK, who made a special study of kleistogamy and who in the course of his studies discovered among the Anonaceae some plants which produce no other flowers than those that never open. This discovery was the

first heavy blow dealt to the ideas prevalent at the time about cross-pollination, which though it would have to take place only occasionally, was at the time assumed to be a necessity for all plants. Also FITTING's observations on the influence of pollen on the flowers of Orchids may be mentioned here, though they might be numbered among the physiological investigations.

TREUB's work on the watercontaining calyces of Spathodea campanulata must also be named here. It was followed by a far more detailed study by KOORDERS, who also devoted his time to other hydathodes of flowerbuds, especially the calyces of Clerodendron Minahassae.

In the field of symbiosis JANSE experimented on the mycorhiza of tropical foresttrees. BURGEFF has of late been studying mycorhiza fungi in Java, especially those found among Orchids. MIEHE and VON FABER occupied themselves with symbiosis with bacteria; these two studied especially the tumefactions on the leaves of some Rubiaceae, which are caused by bacteria.

A group of plants which years ago already attracted attention in Java are those found on the higher mountains. Long ago they were described by JUNGHUHN, who thought that the same conditions prevailed here as in the Alps, of which an alpine flora was the result. Afterwards SCHIMPER among others laid stress on the xerophytic character of this flora and yet hardly any date of the climate of these mountaintops were available at the time. The establishment of an observationpost on the top of Pangerango by DOCTERS VAN LEEUWEN has increased our knowledge about this climate. Observations are regularly made here and a monograph was published the other day by VON FABER, who looks upon these plants as craterplants; he supposes that the soil plays an important part here and it is his opinion that there is no question about an adaptation to an alpine climate.

Are we to mention the investigations by CLAUTRIAU and others on insectivorous pitcherplants under this head or do they belong to the field of physiology? This much is certain that these investigations have begun the study of a group of plants a great many species of which are found in the Dutch East Indies and of whose conditions of life very little is known. The same might for that matter be said in a good many cases: every botanist who reaches Java or rather who sees the Dutch East Indies is struck by the great number of problems to be investigated yet.

One of these problems deserves to be mentioned in these pages though I am well aware of the fact that it might be said to belong to the field of geographical botany rather than to the subject in hand. I mean the appearance of a new flora in the isle of Krakatau after it had entirely lost its vegetation in consequence of the wellknown eruption of 1883.

TREUB was the first to call attention to this problem and visited the island several times. Others have followed his example and at present it is especially DOCTERS VAN LEEUWEN, who devotes his time to observations of this kind. It will hardly be necessary to say that it is of the last importance to find out by means of an experiment on a large scale, like the one made by nature itself in this island, what are the first plants

The new visitors' laboratory at Tjibodas, situated close to the primeval forest on the slope of the Gedeh mountain.

that can develop in a virgin soil and in the second place how these are gradually ousted by others. The spectacle of the struggle for life is enacted before our eyes in this island so that we need not theorise about it. It is sometimes maintained that in a tropical jungle the struggle for life is something terrible, but here, too, it was TREUB, who called attention to the fact that in most of these forests an equilibrium is found in consequence of which a struggle for life as the term is generally understood is hardly noticeable.

A work like the present can only give a very general survey of what has been achieved in the field of general botany in the Netherlands East

Indies, both by Dutchmen and by foreigners. In spite of this the reader's impression will not unlikely be, that a great deal of work has been done in the archipelago. For all that investigators will find that the number of problems to be solved is legion.

It would seem to the present writer that there is no better place than the Netherlands East Indies to study a great many general tropical plantproblems, not only because a vegetation, so luxuriant is to be found nowhere else in the world except in the Amazone-basin or rather in the Northern part of South America, but especially because the laboratories for scientific research in these islands are better equipped than anywhere else in the tropics. Researches can be made at the several experiment-stations or in the Government Botanic Gardens. I should like to mention once again the Treub-laboratory and more especially the laboratory at Tjibodas, this splendid foundation of MELCHIOR TREUB, which in the opinion of the present writer perhaps would better bear the founder's name than the institute at Buitenzorg because it will be impossible to find a more suitable place for research-work than Tjibodas, where experiments can be made not only in the vicinity of the jungle but even in the forest itself and under circumstances closely resembling those under which plants live in the open air.

We can only hope that funds enabling botanists to study in the Dutch East Indies for a considerable time will also be raised in other countries and that in this respect too, there will be a return to pre-war conditions.

# II. THE VEGETATION

by Dr. A. A. PULLE,

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The knowledge of the vegetation in the Netherlands East Indies is not so extensive yet as to enable botanists to give a comprehensive survey of it, though many praiseworthy attempts have been made to do so. Among these may be mentioned an article by Dr. H. J. LAM, who discusses the flora in chapter II of "De Indische Bodem" (The soil of the Dutch East Indies) in which he describes in a concise and popular way 1. the origin of the Indonesian flora. 2. the virgin flora with the principal forms of vegetation and 3. the flora under the influence of man.

A description of the vegetation requires in the first place a detailed knowledge of the species of which it consists. The vegetation of Java may be said to be pretty well-known though no modern handbook of the flora of this island has appeared yet. When we say that the knowledge of the flora of Java is pretty extensive, this means that species of plants unknown to science or which are not known to occur in the island are very rarely met with. Not much is known, however, of the distribution of the various species of plants over the island. Part of the species mentioned by BLUME in his "Bijdragen" (Contributions to the Flora of the Dutch East Indies) 1826, and also in his later works have not been found in Java for nearly a hundred years. Quite recently BACKER and a few other florists and collectors succeeded in finding again specimens of these species for the greater part in their original places. On the strength of this it may be said with certainty that if a flora of Java were to be written now, it would indeed give a survey of the species of plants found in Java, but such a work would by no means be a trustworthy guide for the distribution of these plants over the island. Best known perhaps in this respect are the trees, at least part of them, described in KOORDERS and VALETON "Bijdragen tot de kennis der boomsoorten van Java" (A contribution to the knowledge of trees in Java), based on the many dates collected by KOORDERS. The above remark holds good also for other tropical countries and many of the botanical geographical conclusions based on floras for tropical countries are very doubtful.

With the exception of a few smaller islands or groups of islands

far less is known of the vegetation of the other islands than of that of Java. In the large isles of Sumatra, Borneo, Celebes and New Guinea plants were collected on several expeditions and journeys, the results of which were published in different works but yet a collection of these publications would give anything but a adequate idea of the flora. Hence a flora of the entire archipelago would at most enable the reader to form an idea of floristic knowledge at the present moment. It is necessary that floristic research should be continued energetically because many regions (especially Sumatra) are victimised by civilisation to such an extent that the flora may not unlikely be destroyed before the investigation is over so that many important botanical geographical facts may get lost.

It goes without saying that this scant knowledge of the species makes the existence of good descriptions of forms of vegetation impossible. In this respect, too, more is known about Java than of the other islands, owing to JUNGHUHN's excellent and unsurpassed work (1849—1854). The four zones distinguished by him are admitted by botanists up to this time. The principle of this division is that it distinguished the cloud-zone from the slopes, valleys, upland plains under it and from the mountain tops above it. JUNGHUHN's first zone is the so-called torrid zone as high up as about 700 m. above the level of the sea, which in Java has of course lost its original plantgrowth almost entirely. It has been preserved best along the coasts where we find either a littoral flora or a mangrove vegetation a detailed description of which is found in KARSTEN's "Die Mangrove-vegetation im Malayischen Archipel" 1891, whilst in the same year SCHIMPER described "Die Indomalayische Strandflora". The level beach has lost a considerable part of its natural vegetation owing to the fishponds which have been made there or the sawahs (ricefields) which extend all the way to the sea. Upon the whole the mangrove has been better preserved. The largest area covered by it is in Java from the river Tji Taroem to the Tji Manoek-delta. On the southcoast they are found in great numbers on the banks of the Segara Anakan (Kinderzee) near Tjilatjap. Immediately behind the beach-wood a zone in which Nipa fruticans is often found, is characterised by the predominance of certain species such as Barringtonia speciosa, Calophyllum Inophyllum, Hibiscus tiliaceus and Casuarina equisetifolia. In the interior the mixed wood used to be the prevailing vegetation but in the lowest zone of JUNGHUHN this has been able to stand its ground only in a few places. Civilisation has almost destroyed it. In East Java where the monsoon differences are more strongly marked than in the western part of the island the growth of trees is less luxuriant. In Eastern Java homogeneous woods are found even near the coast. The best known specimen of these is the teakwood is which Tectona grandis prevails

and which in found especially on the Northern limestone mountains and on Gunung Kěndĕng. Species of Acacia and Albizzia may be found as savannah woods in the East.

JUNGHUHN's second zone, the so-called temperate zone, reaching up to 1350 m. contains the best developed primeval forests in which the species of trees are the most numerous so far as they have not been destroyed by the growth of cinchona and tea.

The forests of the cool zone i.e. those of the cloud zone in East Java differ considerably from those of West Java. Mixed woods prevail in the western part of the island but the foliage is less dense, the phanerogamous epiphytes become smaller in number, their place being taken by epiphytic mosses and ferns. Treeferns, too, increase considerably in number. In many higher regions a thick growth of epiphytic mosses covers the trunks and branches, or the moss hangs down in veils from the trees. Species of Quercus, Castanopsis and a number of conifers are characteristic of this zone. In the East of Java where the formation of clouds is less frequent the mixed wood is less prevalent. Casuarina woods with hardly any underwood and few lianas are found here, whilst as a rule phanerogamous epiphytes are not found.

On the mountaintops above the cloudzone the woods change into shrubs or savannah-like vegetations appear.

JUNGHUHN's descriptions of the vegetation have been supplemented and corrected by several smaller publications. The names of the species mentioned in these descriptions have been modernised but not many new things have been added to them. Several studies by Dr. W. DOCTERS VAN LEEUWEN on "De plantengroei van de hoogste bergtoppen van Java" (The vegetation on the highest mountaintops in Java) and a number of articles in "De tropische Natuur" (Tropical Nature), a periodical, appearing in the Dutch East Indies, have given much valuable information about the flora of the highest mountains. The same periodical also contains numerous descriptions of the vegetation in other parts of Java, often short but interesting reports of excursions e.g. L. G. DEN BERGER on the vegetation of the Vorstenlanden (the Principalities), H.A.B. BÜNNEMEYER on the Diëng plateau, J. BEUMÉE on the Karang mountains and Rembang whilst the numerous articles by C. A. BACKER on plants of the dunes in the Netherlands East Indies deserve to be mentioned as well.

Descriptions of the vegetation in other islands are very few and far less complete than those of Java. With respect to the vegetation in Borneo mention may be made of BECCARI's articles "Nelle foreste di Borneo" (1902) translated into English as "Wandering in the great forest of Borneo" (1904), whilst Engler's Jahrbücher Band 50 suppl. contains an article by H. WINKLER on "Die Pflanzendecke Süd-Ost Borneo's".

The descriptions by STAPF and GIBBS of the flora of Kinabalu and H. HALLIER's description of the Kĕlam give us some information about the high mountains in Borneo. HANS WINKLER travelled through Central Borneo (1924—'26); the reports of his travels written by himself and by others are now beginning to appear in "Mitteilungen aus dem Institute für allgemeine Botanik, Bnd VII, 1927". Even less is known of the vegetation of the other islands. Mention may be made of JUNGHUHN's "Die Battaländer auf Sumatra" (1854) and KORTHALS "Blik op de natuurlijke gesteldheid en vegetatie van een gedeelte van Sumatra" (A survey of the character of the soil and the vegetation of part of Sumatra). For the eastern part of the archipelago, too, there exist but few descriptions of the vegetation which are of any use. The greater part of these are found in books of travels. Of great importance is KOORDERS' "Verslag eener botanische dienstreis door de Minahassa" (Report of a botanic tour in the Minahassa undertaken by order of the government) and WARBURG's "Vegetationsschilderungen aus Süd-Ost Asien".

Short but detailed and mostly beautifully illustrated descriptions of the vegetation are found in several parts of KARSTEN and SCHENCK's "Vegetationsbilder", among which the following may be mentioned: G. KARSTEN, "Vegetationsbilder aus dem malayischen Archipel" in Reihe I; the same on "die Mangrove-vegetation"; M. BÜSGEN, HJ. JENSEN and W. BUSSE, "Vegetationsbilder aus Mittel- und Ost-Java" in Reihe III; RECKINGER, "Vegetationsbilder aus dem New-Guinea-Archipel" in Reihe VI; A. ERNST "Die Besiedelung vulkanischen Bodens auf Java und Sumatra" in Reihe VII; G. SENN, "Tropisch-asiatische Bäume" in Reihe X; K. DOMIN, "Vegetationsbilder aus Java, vorwiegend aus der Urwäldern der West-Javanischen Vulkane" in Reihe XI; H. J. LAM, "Vegetationsbilder aus dem Innern von Neu-Guinea" in Reihe XV and G. KARSTEN "Das Licht im tropischen Regenwalde" in Reihe XVI. Botanists have only quite recently begun to study New-Guinea. The greater part of the publications on the vegetation of this island is of a purely floristic nature. Descriptions of the vegetation occur in GIBBS's "Phytogeography and Flora of the Arfak-Mountains" (1917); H. J. LAM has given a very good survey, written in Dutch of the vegetation of the regions visited by him.

It goes without saying that before these, other works on the Flora of the Archipelago were written of a purely floristic nature i.e. works which give exclusively a description and an enumeration of the species and the places where they are found [1].

[1] The following survey has partly been borrowed from the present writer's article on botanic literature in the second edition of the Encyclopaedia for the Dutch East Indies, which in its turn was a revision (with some additions) of J. G. BOERLAGE's article in the first edition of this Encyclopaedia.

The first more detailed accounts are found in JACOB BONTIUS, whose six books on the natural history of the Dutch East Indies in G. PISO's work "De Indiae Utriusque re naturali et medica Libri XIV" were published in 1658. In these books BONTIUS gives the pictures and descriptions of some sixty plants, mentions their medical properties and gives directions as to the way in which they must be made use of. Though

G. E. RUMPHIUS,
the author of the "Herbarium Amboinense".

the descriptions are not very exhaustive and the pictures far from beautiful it is not difficult to recognise the plants. Of far greater importance is the famous work by G. E. RUMPH (mostly called RUMPHIUS) whose "Herbarium Amboinense" though for the greater part written before 1700 was published only between 1741 and 1750 through the good offices of JOHANNES BURMAN. RUMPHIUS's work with its accurate and detailed descriptions and pictures of Indian plants was of less local

importance than its title might suggest, for it contains the first description not only of plants found in Ambon but a great many species of plants which are very common all over the archipelago. Seing that the Herbarium Amboinense appeared before the first edition of LINNAEUS's Species Plantarum, the names used by RUMPHIUS were not introduced into the nomenclature afterwards and hence his name is not found as the author's name to the genera of the Netherlands East Indies. The names found in the Herbarium Amboinense have been changed so as to correspond with those of later periods, both by BURMAN in the work itself and by others after him. A detailed explanation of the names was given by J. K. HASSKARL (1866) "Neue Schlüssel zu RUMPH's Herbarium Amboinense" in the „Abhandl. der Naturforschenden Gesellschaft in Halle IX". The newest key is E. D. MERRILL's (1917), which is based on the collections made in Ambon by C. B. ROBINSON (1913), ("An interpretation of RUMPHIUS's Herbarium Amboinense"). It has been possible after the labours of MERRILL and ROBINSON to reduce the 1700 species mentioned by RUMPHIUS to 1200, of which number 1000 species have now been with certainty identified with species known at present.

In 1768 BURMAN's son, N. L. BURMAN published a "Flora indica", which also contains a number of Javanese plants. The end of the eighteenth century did not produce many works of great importance on the Java flora. Among these are J. C. M. RADEMACHER's "Naamlijst der planten, die gevonden worden op het eiland Java" (1780—'82) (A list of plants found in the isle of Java); F. VON WURMB, "De orde der Palmboomen" (Palmtrees) (1779), and F. NORONHA, "Altingia excelsa". To these may be added a few shorter articles written under the supervision of the Swedish professor THUNBERG, based on the materials collected on his journeys, one of which was a visit to Java. One of these is a "Florula Javanica" by WIMBERG and WILDMARK (1825), which consists only of a list of plants. It does not mention the places where the plants were found or any other data and it gives but few descriptions at the end, among which there are some of new species, overlooked by those who wrote about the same subject afterwards.

LESCHENAULT DE LA TOUR, who travelled round the world (1800—1804) also visited Java, Madura and Timor from where he brought home an important herbarium. He published several particulars about it in the account of his journey: "Relation abrégée d'un voyage aux Indes Orientales" (Mém. du Mus. d'Hist. Nat. IX) whilst he wrote at some length about some subjects such as the Upastree, Antiaris toxicaria. His herbarium, which found a place in the Natural History Museum in Paris, afterwards supplied the materials for the description of a number of new species in Java and a flora of Timor. A similar journey undertaken

by LOUIS DE FREYCINET (1817—'20) in the Uranie and la Physicienne, on which he was accompanied by the naturalist CHARLES GAUDICHAUD provided the latter with the materials for his „Botanique du Voyage autour du monde" etc. (1826), a work containing 120 pictures, which also describes several plants of the Dutch East Indies especially those found in Timor and the isle of Rawak, near New Guinea. These are found also among the plants collected by LESSON on DUPERREY's Journey round the world in the corvette LA COQUILLE (1822—'25) on which journey Amboina was also visited. The botanic materials were studied by DUMONT D'URVILLE, BORY DE ST. VINCENT and BRONGNIART, (Voyage autour du monde, exécuté par ordre du roi sur la corvette LA COQUILLE, en 1822—1825: Botanique 1828); DUMONT D'URVILLE was captain of the Astrolabe (1826—1829) on board of which the collecting of plants was entrusted to the chemist LESSON. Several places in the eastern part of the archipelago were visited. The botanic part of the record of this journey was written by LESSON and RICHARD: "Voyage de la Corvette l'Astrolabe, Botanique 1832". Once again DUMONT D'URVILLE travelled in the Astrolabe and the Zélée, and visited the Moluccas and the Aru-islands. The plants collected by the ship's doctor HOMBRON were studied partly by himself and partly by MONTAGNE and DECAISNE: "Voyage au Pole Sud et dans l'Océanie sur les corvettes l'Astrolabe et la Zélée, 1837—1840, Botanique 2 vol. 1845".

An important event was the foundation of the Government Botanic Gardens at Buitenzorg in 1817. They were founded by professor G. C. C. REINWARDT, who did not publish much in his lifetime, though his biography written by DE VRIESE gives evidence of the fact that he studied much during his stay in Java. Mention may be made here of his Sylloge plantarum novarum, published in the Regensburg Flora (1825, 1826) and his speech in the Berlin Academy of Science "Ueber den Character der Vegetation auf den Inseln des Indischen Archipels" (1828). DE VRIESE has also edited a more or less coherent edition of REINWARDT's collections of plants (Plantae Indiae batavae orientalis, quas in itinere per insulas Archipelagi Indici Javam, Amboinam, Celebem, Ternatem, aliasque annis 1815—1821 exploravit G. C. C. REINWARDT, Leiden 1856). His successor BLUME on the other hand published a number of most important writings within a short time of each other. These works contain information about BLUME's own collections and of those collected by REINWARDT's assistants KUHL and VAN HASSELT. The first work was "Catalogus van eenige der merkwaardigste gewassen, zoo in- en nitheemsche te vinden in 's Lands Plantentuin te Buitenzorg", (A catalogue of some of the most remarkable indigenous and foreign plants, to be found in the Government Botanic Gardens at Buitenzorg) 1823.

Others are "Beschrijving van eenige gewassen, waargenomen op een tocht naar de Salak in 1822", (A description of some plants seen on an expedition to the Salak in 1822) 1823; "Bijdrage tot de kennis onzer Javaansche Eiken" (On Javanese oaks) 1825; "Over de gesteldheid van het gebergte Gedeh" (On the character of the Gedeh mountains) 1825; "Korte beschrijving van de Patma der Javanen" (A short description of the Patma of the Javanese) 1825; "Tabellen en platen voor de Javaansche orchideeën" (Lists and pictures of Javanese orchids) 1825; "Monographie der Indische pepersoorten" (A monograph on the species of Piper found in the Dutch East Indies) 1826; "Bijdragen tot de Flora van Nederlandsch Indie" (Contributions to the flora of the Dutch East Indies) 1825—'26. The last work was of great importance for the knowledge of the flora in the Dutch East Indies inasmuch as it gave a description of no fewer than 150 new species, several of which were types of new genera. When BLUME had to leave Java in 1826 on account of ill-health he took with him a considerable part of the plants collected by himself and his predecessors. By decree of the government this collection was made use of to found a national herbarium, of which BLUME was appointed director, which enabled him to continue his investigations about the flora of the Indies. Together with J. B. FISCHER he now began to work out his materials for the Flora Javae, a folio-volume with 238 coloured pictures of which from 1828 onward some 11 families were published within a short time of each other, whilst in the mean time some smaller works written by him appeared. The edition of the Flora Javae was now stopped for some time and instead of it appeared another folio-volume Rumphia, consisting of 4 volumes with 200 pictures, most of them coloured (1835—1845). In 1845 its place was taken by "Museum Botanicum Lugduno-Batavum", containing a series of descriptions of the analyses of the plants discussed. At last in 1858 a new series of the Flora Javae was begun, of which, however, but one part — containing the orchids — was to appear. BLUME had studied this family in Java, whilst afterwards part of the plants collected by KUHL and VAN HASSELT had been studied by VAN BREDA, whose "Genera et species Orchidearum et Asclepiadearum" had been published in 1827 but was not completed in consequence of the revolt of the Belgians in 1830.

Though BLUME had a great number of notes and sketches together with a large herbarium at his disposal, it is necessary to bear in mind — when we wish to form an opinion of his works — that for the description of many species his material was far from complete and consisted of dried plants. Though this is not the case with some families discussed in Flora Javae or Rumphia, about which he had made many notes in Java and a great number of specimens of which he had taken with him

when he left the island, yet in a good many cases he had only one single dried plant at his disposal. This observation holds good for part of the species described in his "Bijdragen" (Contributions) as well as for those of his later works for though BLUME wrote these during his stay in Java, the contents of these writings were probably for the greater part based on materials collected by REINWARDT, KUHL and VAN HASSELT. His Museum Botanicum is exclusively a herbarium-work, especially because the greater part of the plants used by BLUME for his compilation had been collected by others. For all that BLUME's vast knowledge of plants together with the extensive collection of materials (to which also belonged WALLICH's collections, which he had at his disposal at the time) make his Museum Botanicum a valuable work which may be classed among the best publications on the flora of the Dutch East Indies.

About the same time when the study of the flora of Java was begun, important discoveries were also made about the flora of Sumatra. WILLIAM JACK, a young Scotchman, accompanying Sir STAMFORD RAFFLES on his expeditions as physician and secretary from the end of 1818 till 1822, had found a number of remarkable plants in the islands of which he gave a description in the Sumatran Mission Press; some of them were also mentioned in the Transactions of the Linn. Soc. Owing to the way in which they were published JACK's writings were not accessible to most botanists; hence they were afterwards reprinted in HOOKER's "Botanical Miscell. I" (1830—1831), HOOKER's "Journal I" (1834) and HOOKER's "Companion I" (1835). A second reprint appeared at Calcutta "Journal of Nat. Hist. IV" (1843). JACK's writings published as "Descriptions of Malayan Plants" were the first to give some more or less detailed information about the flora of Sumatra. Before him some data had been supplied by MILLER, who had visited Sumatra (1770—1772). Some information about his travels and the plants observed by him appeared in Philos. Transact. 1778. A description of some Sumatran plants is also found in RETZIUS "Observationes botanicae". To the retinue of Sir STAMFORD RAFFLES on his expedition in Sumatra belonged also an Englishman THOMAS HORSFIELD, who had travelled in the Netherlands East Indies from 1802, especially in Java and Banka. He had collected a large herbarium and made a number of notes about the vegetation of Java. He himself did not publish much about this; the "Verhandelingen van het Bataviaasch Genootschap" contain a short article written by HORSFIELD on the medicinal plants of Java, a description of the Gatip-tree (Inocarpus edulis); an essay on the Upas tree, Antiaris toxicaria, and a description of Crinum asiaticum. The greater part of his notes together with his plants, however, served as material for the Plantae Javanicae Rariores, a quarto-volume with many good illustrations pu-

blished by BENNETT and BROWN (1838—1852). This work is of great importance for Eastern Java, very few plants of which had been described at the time. HORSFIELD's herbarium was afterwards revised by MIQUEL for his flora so that this work contains all the plants collected by HORSFIELD in Java and Banka, among which there are several which do not occur in BENNETT and BROWN's work. A report on the herbarium of Timor, collected during the journey of LESCHENAULT DE LA TOUR was published by DECAISNE (1835). Afterwards SPANOGHE collected a large number of plants in Timor, which he discussed in Linnaea XV (1841) under the name of Prodromus Florae Timorensis.

Of no less importance to the knowledge of the flora of the island were the plants discovered by ZIPPELIUS. Together with those found by SPANOGHE they provided BLUME and MIQUEL with the materials for many new species. Afterwards H. O. FORBES also made a herbarium there, the contents of which are mentioned in his "Naturalist's Wanderings in the Eastern Archipelago" (1885).

By order of the government P. W. KORTHALS had made botanical investigations in various parts of the archipelago, Java, Sumatra, Borneo (1828—1834). The results of his investigations were published partly in a number of short essays such as "Aanteekeningen over eenige soorten van Loranthus" (Notes on some species of Loranthus); "Verhandelingen over de op Java, Sumatra en Borneo verzamelde Loranthaceae" (A dissertation on Loranthaceae collected in Java, Sumatra and Borneo); "Overzicht der Magnoliaceae en Rubiaceae van de N.O.I. Kolonien" (A survey of the Magnoliaceae and Rubiaceae of the Dutch East Indies); "Observationes de Naucleis Indicis"; "Opmerkingen over Gnetum en eenige Conifeeren" (Observations on Gnetum and some Coniferae); "Over het geslacht Tupeia" (On the genus Tupeia); "Blik op de natuurlijke gesteldheid en vegetatie van een gedeelte van Sumatra" (A survey of the character of the soil and the vegetation of a part of Sumatra); "Opmerkingen omtrent het geslacht Nepenthes" (Observations on Nepenthes); "Tridia and Pellacalyx, new families of plants"; "Aanteekeningen over Paederia" (Notes on Paederia); "Overzicht der Sterculiaceae and Büttneriaceae van de N.O.I.-bezittingen" (A survey of the Sterculiaceae and Büttneriaceae of the Dutch East Indies), to which may be added a number of geographical and ethnographical observations, all of them published between 1830 and 1848. The other results of KORTHALS's researches are found in the volume on botany (Botanie) belonging to the "Verhandelingen over de Natuurlijke Geschiedenis der Nederl. O.I. Bezittingen door de leden der Natuurk. Commissie" (Essays on the natural history of the Dutch East Indies, written by the members of the Natural-History Committee). This volume, published 1829—1844, contains an accurate

and detailed discussion of several families and has beautiful coloured illustrations. It gives not only an excellent reproduction of the outward appearance but also the analyses of the characteristic parts.

With BLUME's departure scientific work in the Government Botanic Gardens had come to an end. The curator of the Gardens ZIPPELIUS, a men of great merit, who would no doubt have continued the work excellently, died a short time afterwards (1828) on a journey to Timor and New Guinea. The plants he had collected there and in Java were afterwards taken to the State Herbarium at Leiden. ZIPPELIUS had made important notes on these plants, which were afterwards used both by MIQUEL and BLUME in their publications of the species which he had discovered. Of the last importance were the plants found in New Guinea because they were the first plants of this island that were ever known.

A period in which much work was done began when J. C. HASSKARL was appointed assistant-curator at the Government Botanic Gardens. At the suggestion of DIARD, HASSKARL undertook to make a systematic arrangement of the gardens and at the same time he began to compile the catalogue in the same way. The catalogue was finished in 1839 but was not printed until 1844 after having been entirely revised by HASSKARL, at least for some families, after the appearance of ENDLICHER's Genera Plantarum". The catalogue contained not only a list of the names of the plants grown in the gardens but also a number of descriptions of new species. When HASSKARL returned to Holland (1843) on account of ill health he published a number of excellent descriptions of 400 Javanese plants — his Plantae Javanicae rariores, 1848 — based on the materials he had collected in the Indies, where he had studied the plants themselves. He had published a number of important writings on this subject before, such as: "Plantarum rariorum Horti Bogoriensis Decades"; „Adnotationes de plantis quibusdam Javanicis"; "Papilionacearum quarundam Javanensium descriptio", all of them in the Tijdschr. v. Nat. Gesch. en Physiol., also in the Regensburg Flora (1842—1844) „Plantarum genera et species novae et reformatae javenses"; "Leguminosarum quarundam Javensium descriptiones novae aut emendatae", "Plantarum Javanicarum aut novarum aut minus cognitarum adumbrationes" and "Aanteekeningen over het nut door de bewoners van Java aan eenige planten van dat eiland toegeschreven" (1845) (Notes on the useful qualities which the Javanese ascribe to some plants growing in the island). These writings are the result of HASSKARL's first and his second stay in Java; the fruits of his third visit to the island are "Retzia sive Observationes botanicae quas de plantis horti Botanici Bogoriensis Annis 1855 et 1856 fecit"; his "Filices Javanicae" (1856); his "Hortus Bogoriensis descriptus sive Retziae editio nova" (1858). After his return home he wrote a key to RUEEDE's "Hortus

Malabaricus" and RUMPHIUS's' "Herbarium Amboinense" and also published a monograph on the Indian Commelinaceae (1870). When HASSKARL left Java his herbarium was left behind at Buitenzorg, as he had distributed but few duplicates of it and part of his plants had got lost at Buitenzorg, the authentic specimens of several species described by him exist no more.

H. ZOLLINGER, a Swiss had already attracted attention by his "Observationes phytographicae praecipue genera et species nova nonnulla respicientes" (1844) and his "Opgave der planten gezien sedert een kort verblijf op Java" (1845) (A survey of the plants seen during a short stay in Java). By these writings but also by the distribution of numbered collections of the plants gathered by him he has done signal service to our knowledge of the flora of the Netherlands East Indies. These collections were sent to the Swiss professor A.MORITZI, who controlled what ZOLLINGER had identified and described and saw to the distribution. MORITZI's "Systematisches Verzeichnis der von H. ZOLLINGER in den Jahren 1842—1844 auf Java gesammelten Pflanzen" (1846) refers to these collections. ZOLLINGER's herbaria provided a number of investigators with materials which enabled them to publish important information about the flora of Java; among them was the Russian TURCZANINOW, who in "Animadversationes ad Catal. Herb. Unic. Charkow" (Bull. Soc. Imp. Moscow 1863) described several new species found in this island.

F. W. JUNGHUHN, a medical officer made his collections in Java a short time before ZOLLINGER and also during the time that the latter visited the island. JUNGHUHN was in Java from 1836—1848 and devoted what time he could find to scientific investigations, among which the knowledge of the flora took a prominent place. Of his numerous writings the following may be mentioned: "Praemissa in Floram Cryptogamicam Javae insulae" (1838); "Diagnoses et adumbrationes stirpium nonnullarum novarum vel minus cognitarum Florae Javae alpinae indigenarum" (1845); "Die Balanophoreae der Insel Java" (1841) (The Balanophoreae of the isle of Java); "Physiognomie van de Flora der toppen der Javaansche bergen" (1845) (A physiognomy of the flora of the mountaintops in Java); "Die Battaländer auf Sumatra" (1847). Much of what he mentioned about the flora of Java is found again in "Java", his famous work, the first Dutch edition of which appeared in 1849 and was followed by a second in 1853; the next year a German translation by HASSKARL appeared. Though JUNGHUHN described many new species too, he experienced the difficulties of having to work systematically without having the proper materials for comparison for which reason he put his extensive herbarium into the hands of several botanists whose work was published in "Plantae Junghuhnianae" (1851—1855).

The reader who wishes to know more about JUNGHUHN is referred to the "Gedenkboek FRANZ JUNGHUHN 1809—1909", (Memorial volume FRANZ JUNGHUHN 1809—1909), which appeared in 1910 on the occasion of the centenary of his birth and contains a detailed bibliography of JUNGHUHN's works together with much information about his botanic collections.

Another student of the flora of the Netherlands East Indies is the Leyden professor DE VRIESE. The greater part of his publications on this

F. W. JUNGHUHN, the author of "Java".

subject appeared before he visited the archipelago so that they are not based upon observations of the vegetation of the Netherlands East Indies on the spot. In the hothouses of the Leyden botanic gardens he found the materials for his "Descriptions et figures de plantes nouvelles et rares du Jardin Botanique de Leyde" (1847—1851). Important also are his "Illustrations d'Orchidées des Indes Orientales Néerlandaises" (1854); "Illustrations des Rafflesia Rochussenii et Patma" (1854); "Mémoire sur le Camphrier de Sumatra et Borneo" (1856) and especially his "Plantae Indiae Orientalis, quas exploravit G. REINWARDT" (1856—1857). On his journy

through the Netherlands East Indies he collected rich materials in Java, Sumatra, Borneo, Celebes and the Moluccas, which afterwards enabled MIQUEL to describe a number of new species in his Annales.

The curator of the gardens J. E. TEYSMANN, who came to Java in 1830 acquired an extensive knowledge of the Indian flora during his stay there. In his publications, which were begun about 1850 he mostly described the journeys he undertook and the plants he collected; sometimes he also drew attention to plants which were of importance for commerce and industry. In collaboration with his assistant BINNENDIJK he published a number of good descriptions of new species (1862—1867) entitled "Plantae novae in Horto Bogoriensi cultae"; an equally important work compiled by TEYSMANN and BINNENDIJK was the new "Catalogus van 's Lands Plantentuin" (A catalogue of the Government Botanic Gardens) 1866.

A splendid work suggested to the author by the wealth of plants in the Government Botanic Gardens appeared in 1863. This was BERTHA HOOLA VAN NOOTEN's "Fleurs, fruits et feuillages choisis de la flora et de la pomone de l'île de Java" .This large foliovolume contains 41 splendid coloured pictures with legends in French and English. A German, S. KURZ, who had gone to the Indies as a soldier under the assumed name of J. AMAN, worked in the gardens for a considerable time. He drew the attention of botanists by "Eene opsomming der Vaatcryptogamen van het eiland Bangka" (An enumeration of the vascular Cryptogams of the isle of Bangka; "Eenige kruidkundige mededeelingen" in 1864 en 1865 (Some botanic information), which appeared in the "Nat. Tijdschrift v. Ned. Indië", at first under his assumed name, but afterwards under his own name. From Buitenzorg he went to Calcutta where he wrote several scientific articles in the "Journal of the Asiatic Society" (1869—1875); one of these was on the plants of the Dutch East Indies.

The Utrecht professor F. A. W. MIQUEL collected everything that had appeared and undertook the task of compiling a flora of the Netherlands East Indies. He had done work of this kind before. Before his flora he had published "Commentarii phytographici" in which he examined several families (1834—'40); "Monographia Cycadearum" (1842); "Systema Piperacearum" (1843—1844); "Revisio critica Casuarinarum" (1840); "Analecta botanica Indica" (1850—1852) and a study of a good many of the families in the "Plantae Junghuhnianae". In 1855 he began the publication of his "Flora Indiae Batavae", which lasted till 1859. In spite of its many shortcomings this is one of the most valuable works that have been published about the flora of the Dutch East Indies, especially because MIQUEL cited all works that had appeared on the subject and mentioned in his flora all data these works contained. The

compiler did not content himself with collecting the data supplied by the various works but also examined the materials of his predecessors as far as they were available. He had succeeded in obtaining for inspection from the collections in the State herbarium at Leiden authentic materials which had been studied by BLUME, KUHL, VAN HASSELT, ZIPPELIUS, KORTHALS, SPANOGHE etc. The herbaria of JUNGHUHN, REINWARDT, ZOLLINGER and HORSFIELD were lent to him. Numerous duplicates from the Buitenzorg gardens identified by HASSKARL and others collected by TEYSMANN on his journeys had been sent to him. All these materials had to be made up into one whole. The names found in the works of the writers of former periods had to be changed into those used for the genera in ENDLICHER's Genera Plantarum, which was generally made use of at the time and those of the species in CANDOLLE's "Prodromus". The trustworthiness of the data supplied by these works had now to be established by comparing them with the results of the investigation of herbarium-materials, with other works that had appeared on the subject and with the herbarium of the flora of British India. MIQUEL accomplished this stupendous work in a very short time, but it stands to reason that it was far from being complete. As early as 1862, hence almost immediately after the Flora had appeared, a supplement "De Flora van Sumatra" (The flora of Sumatra) followed in which MIQUEL described 1300 new species principally based on duplicates sent from Batavia, collected partly by TEYSMANN and partly by DIEPENHORST. MIQUEL became more fully convinced of the incompleteness of his Flora when in 1862, in which year he succeeded BLUME, the large collections of the State Herbarium at Leiden were put under his control. The abundance of materials which he found there gave him a better opportunity to study those that BLUME and KORTHALS had made use of for their works than a few borrowed specimens could have done and MIQUEL did not omit to avail himself of the opportunity offered him. In his "Annales Musei Botanici Lugduno-Batavi" I—IV (1863—1869) he examined a number of families and genera closely, for which study he had at his disposal both the materials collected by KORTHALS, ZIPPELIUS, FORSTEN and those gathered by DE VRIESE and TEYSMANN. The result of this investigation was a description of a number of new species. He also gave other botanists an opportunity to study the collection and the results of their investigations were also published in the „Annales", which contain articles by OUDEMANS, DE BOER, SCHOTT, METTENIUS, HASSKARL etc. MIQUEL's own contributions, however, form the principal part of these four folios. After his death a number of M.S.S. were found, which were published in 1871 under the name of "Illustrations de la Flore de l'Archipel Indien". Few only of MIQUEL's pupils applied themselves to the study

of the flora of the Indies. Two theses written under his supervision are about this subject viz. P. DE BOER on the Indian Coniferae and R. H. C. SCHEFFER on the Myrsinaceae. The latter was one day to be a prominent man in the botanical world of the Indies, inasmuch as he was in 1868 appointed director of the Government Botanic Gardens and started for the Indies. His first publications appeared in the "Nat. Tijdschr. v. Ned. Indië", which contains his important "Observationes phytographicae" (1870—1873). Afterwards he started the periodical of the Government Botanic Gardens, called "Annales du Jardin Botanique de Buitenzorg", which on its first appearance contained an "Opnoeming van de planten op N. Guinea door TEYSMANN verzameld" (A list of plants collected by TEYSMANN in New Guinea) and a few other articles written by SCHEFFER himself, whilst it contained articles written by other members of the staff (TEYSMANN, BINNENDIJK, WIGMAN) as well. At his death (1880) he left behind many manuscript-notes, which were published in the second volume of the Annales after part of them had been revised by O. BECCARI (Reliquiae Schefferianae). This Italian traveller who visited several parts of the Malay archipelago from 1868—1878 was one of the few foreign botanists who in those years studied the flora of the Indies. He first published the results of his investigations in the "Nuovo Giornale Botanico Italiano" (1868—1869), and afterwards in the three volumes of his "Malesia" (1877—1890).

After SCHEFFER's death systematic work in the Government Botanic Gardens was continued by BURCK, who published two monographs viz: on the Sapotaceae and the Dipterocarpaceae in which he described several new species. Besides these monographs the "Annales de Buitenzorg" contained floristic articles written by several visitors of the gardens, such as SOLMS-LAUBACH, KARSTEN, BOERLAGE and others. The flora of Java was studied by S. H. KOORDERS, who published "Bijdragen tot de kennis van de Boomflora van Java" (Contributions to the knowledge of the trees of Java) which he started by publishing the "Lijst der geslachten van de Boschboomen van Java" (A list of the species of foresttrees in Java), which appeared in 1892 in the "Nat. Tijdschr. van Ned. I." His "Zakflora of Sleutel voor de geslachten en families der Woudboomen van Java" 1893 (A pocketflora or key to the genera and families of the foresttrees in Java) and his „Plantkundig Woordenboek van de Boomen van Java" 1894 (A botanical dictionary of the trees in Java) followed after a short time. The dictionary, which appeared as "Mededeelingen van 's Lands Plantentuin" contained a revision of the native names and their relation to the scientific names. In 1894 Dr. TH. VALETON began to study the trees in Java in collaboration with Dr. S. H. KOORDERS, the results of which were published in the "Mede-

deelingen van 's Lands Plantentuin" with the title "Bijdragen tot de kennis der Boomsoorten van Java" (Contributions to the knowledge of the trees in Java). This large work was regularly continued until in 1914 the last volume (the 13th) appeared. The two volumes published since 1909 have been entirely written by Dr. J. J. SMITH.

In Europe, too, the Indian flora was studied. J. G. BOERLAGE published "Handleiding tot de kennis der flora van Nederlandsch Indie" (A handbook for the study of the flora of the Dutch East Indies), a detailed description of the families and genera of the Indian flora, a work left unfinished after the death of the author (1900).

Among the general works referring to the flora of the Indies may be mentioned one began by BOERLAGE in 1897, the Icones Bogoriensis, an illustrated work with descriptions and pictures of new species from the Buitenzorg gardens or from collections made in various places in the archipelago. This work is not yet finished; an important part of it has been written by Dr. TH. VALETON and Dr. J. J. SMITH.

After 1900 the knowledge of the Java flora has made great progress. A very meritorious work, belonging to floristic works of a more general nature, is a flora of Batavia by C. A. BACKER, of which, however, only the first part appeared (1907). This investigator after having become an assistant at the herbarium of the Department of Agriculture, continued his study of the vegetation of Java. In 1908 he published the first part of a "Voorlooper eener schoolflora van Java" (A prodromus of the flora of Java), the first work of the kind, which may be compared with the floras used in the schools of the mother country. In 1911 the same author published the first part of a "Schoolflora van Java" (A flora of Java for schools), a work on a broader basis than the preceding one. More elaborate still is C. A. BACKER's "Handboek voor de Flora van Java" (A handbook of the flora of Java), three parts of which appeared (1924—1928) but which will not be continued. Of great importance for the vegetation of the cultivated areas is the beautifully illustrated work by C. A. BACKER and DR. D. F. VAN SLOOTEN "Geïllustreerd handboek der Javaansche theeonkruiden en hunne beteekenis voor de cultuur" 1924 (An illustrated handbook of Javanese teaweeds and their significance for the growing of tea); the last publication of this kind is again a newly begun work by C. A. BACKER, entitled "Onkruidflora der Java'sche suikerrietgronden" (A flora of the sugarcane-weeds in Java), the first part of which appeared in 1928 together with an atlas forming vol. VII of the handbook for the sugarcane cultivation and the manufacture of canesugar in Java. All these works must be looked upon as attempts to compile a flora of Java, a work which is wanted badly now that MIQUEL's work is out of date in every respect.

In the meantime Dr. S. H. KOORDERS published his "Exkursionsflora von Java, mit besonderer Berücksichtigung der im Hochgebirge wildwachsenden Arten" 1911—'12, an extensive work in three volumes which as indicated by the title is in the first place a popular flora of the high mountains but which also tries to give a survey of the entire flora of Java, inasmuch as it also makes mention of the species growing under 1800 m. Since 1913 a separate volume containing only pictures has been added to this work. In the same year the publication was begun of an "Atlas der Baumarten von Java" published under the supervision of Dr. KOORDERS, the aim of which is the publication of the pictures of the trees described in the "Bijdragen tot de kennis van de boomsoorten van Java" (Contributions to the knowledge of the trees of Java). In 1898 the first part of a flora of Buitenzorg appeared; only 6 volumes have been published and it would seem that the work will not be continued. Of the higher plants this work contains only a description of orchids (1905) by J. J. SMITH, who described not only those found in the surroundings of Buitenzorg but gave an exhaustives tudy of all orchids known to exist in Java. An atlas belonging to this work appeared between 1908 and 1914, whilst a great number of supplementary articles by the same author appeared in the publications of the Government Botanic Gardens. Mention must also be made of an essay on the Javanese Piperaceae by S. H. KOORDERS in the Proceedings of the Royal Academy of Sciences in Amsterdam in 1907; others by Dr. TH. VALETON on several families in the Bulletins published by the Government Botanic Gardens and in those published by the Board of Agriculture; studies by HARMS on Indian Araliaceae in the "Annales" of 1904 and those by HALLIER on several families of plants in the "Annales" of 1896 and 1897. Of importance not only for Java but for the whole archipelago are: A monograph on the Myristicaceae by O. WARBURG; a study of Cyperus by J. VALCKENIER SURINGAR; a detailed description of the Indian species of Ficus in the Annals of the Botanic Gardens Calcutta by G. KING and BECCARI's large work on Asiatic Palms, which appeared in the same Annals (1908—1912). Of importance also is a study of the Javanese oaks by VON SEEMEN.

With the exception of New Guinea, which has all of a sudden roused the interest of botanists the other islands of the archipelago have not attracted so many students so that our knowledge of the flora of these has not increased so much as that of the vegetation of Java. After the publication of the older collections made by ZIPPELIUS and TEYSMANN, (the latter of which was published by SCHEFFER in the first part of the Buitenzorg Annals), the flora of Dutch New Guinea was not studied till 1903. Our German neighbours began a more detailed study of the flora of this island. K. SCHUMANN published his "Flora der Deutsch-Ostasiatischen

Schutzgebiete" 1888; this was followed by a Flora of Kaiser Wilhelmsland by SCHUMANN and HOLLRUNG (1889). In 1891 WARBURG published his "Beiträge zur Kenntniss der Papuanischen Flora" and in 1900 K. SCHUMANN and C. LAUTERBACH published a large "Flora der deutschen Schutzgebiete an der Südsee"; a supplement to this work appeared in 1905. Since 1910 ENGLER's Botanische Jahrbücher have regularly contained very extensive articles on the "Flora von Papuasien" in which many new collections found in German New Guinea are described. Some botanic articles on British New Guinea had meanwhile appeared. FERDINAND VON MÜLLER wrote on plants collected in the high mountains by MAC GREGOR, who also published several "Descriptive Notes on Papuan plants". The series of publications on the vegetation in the Dutch part of New Guinea was begun by Dr. TH. VALETON with an article on "Plantae papuanae" in the Bulletin du Département de l'Agriculture aux Indes néerlandaises X, 1907. When after 1903 it seemed that New Guinea would be explored regularly in the near future. The "Maatschappij tot bevordering van het natuurkundig onderzoek der Nederlandsche Koloniën" (Society for the promotion of physical research in the Dutch East Indies) determined to start a work called "Nova Guinea", which was to contain the publication of the scientific study of the materials collected by expeditions and exploring-detachments. In 1909—1912 vol. VIII on botany of this beautifully illustrated work appeared; vol XII followed in 1913—1917 whilst two parts of vol XIV have also appeared in 1924 and 1927; the third part will appear shortly. Certain articles in ENGLER's Botanische Jahrbücher — mentioned above — on the „Flora of Papuasien" also contain some studies of materials collected in the Dutch part of New Guinea.

WARBURG's „Monsunia", a quarto-volume, the first part of which appeared in 1900, but which has not been continued since that time, is in a way the counterpart of BECCARI's Malesia and is of great importance for the knowledge of the flora of the Moluccas. The same botanist has published his impressions of the vegetation in the eastern part of the archipelago in "Die Flora des Asiatischen Monsungebietes" 1890, and "Vegetationsschilderungen aus Süd-Ost-Asien" 1893. KOORDERS gave some information about the flora of North East Celebes in a "Verslag eener botanische dienstreis door de Minahassa" (Report of an official tour undertaken for botanical purposes through the Minahassa). SMITH studied the orchids of Ambon (1905). Of importance for the lesser Sunda islands was Dr. J. ELBERT's Sunda expedition, the botanic results of which were published in 1913 by H. HALLIER in the "Mededeelingen van 's Rijks Herbarium te Leiden" (Publications of the State Herbarium at Leyden) 1913. A great quantity of botanic materials collected on several

expeditions in the eastern part of the archipelago has not been studied yet. The energy with which the botanic staff of the Bureau of Science at Manilla under E. D. MERRILL has taken up the examination of the vegetation in the Philippines will no doubt be of much use for the publication of these materials. In the Philippine Journal of Science, which has appeared regularly since 1906 many essays have been published, which have considerably increased the knowledge of the vegetation in these islands since the appearance of BLANCO's Flora. Of late years the number of monographs on families of plants of the whole archipelago has increased considerably. These monographs will eventually have to furnish the materials for a modern flora of the Netherlands East Indies. They have appeared for the greater part in the third series of the "Bulletin du Jardin botanique de Buitenzorg" but some also may be found in former series. We may mention here the description of some genera of Rubiaceae and Zingiberaceae by TH. VALETON; the Zingiberaceae have also been described by K. SCHUMANN in ENGLER's Jahrbücher Bnd. 29; the Araceae by C. R. W. K. VAN ALDERWERELT VAN ROSENBURGH; Verbenaceae by Dr. H. J. LAM (published originally as his thesis, afterwards revised by the author in collaboration with BAKHUISEN); the Combretaceae and Flacourtiaceae by Dr. D. F. VAN SLOOTEN (which appeared in 1919 as a thesis); the subject was afterwards published at greater length in the "Bulletins"; the Stylidiaceae and the Dipterocarpaceae by the same author; the Sapotaceae and Sarcospermaceae by Dr. H. J. LAM; the Polygonaceae and Nepenthaceae by Dr. B. H. DANSER and the Bombacaceae by BAKHUISEN VAN DEN BRINK. A monograph oft he Bignoniaceae appeared in 1927 as a thesis by C. G. G. J. VAN STEENIS.

Most of the works mentioned above refer to the phanerogamous flora. The number of investigators who have studied the lower orders of plants has always been smaller; it is especially the ferns which have attracted the attention of students. BLUME discussed them in his "Enumeratio Plantarum Javae" (1827) and one of the volumes of his Flora Javae (with 94 pictures) is on ferns. DE VRIESE published a monograph on the Marattiaceae (1853). All Javanese ferns so far as they were known at the time are described in HOOKER's "Species Filicum" (1846—1864) whilst MIQUEL, METTENIUS and KUHN, afterwards BURCK, CESATI and BAKER studied Indian ferns. The Hymenophyllaceae were studied by VAN DEN BOSCH (1861), afterwards (1912) by ROSENSTOCK in "Bulletin du Jardin botanique de Buitenzorg" IIme série, No. 2. The first volume of a Buitenzorg flora (1893) is a work on ferns (Pteridophyta) by RACIBORSKI; CHRIST studied the ferns of the Sunda islands Celebes and Borneo (1896, 1898, 1904), dissertations on which appeared in the "Annales" of Buitenzorg, whilst C. R. W. K. VAN ALDERWERELT VAN ROSENBURGH

in his "Malayan ferns" (1908) and in "Malayan Fern Allies" (1915), a hardly less comprehensive work, gave a summary of all that had up to that year been published about the various species of ferns of the Malay Archipelago and the Philippines. Since then the same author has published twelve supplements to his work in the Bulletins of the Government Botanic Gardens. DOZY and MOLKENBOER have published bryological works on the mosses of the Dutch East Indies, the most important of which is "Bryologia javanica" begun in 1855 and continued till 1870 after the death of the authors by R. B. VAN DEN BOSCH and C. M. VAN DE SANDE LACOSTE. MAX FLEISCHER's most important handbook "Die Musci der Flora von Buitenzorg (zugleich Laubmoosflora van Java"), 4 parts, forming the fifth volume of the Buitenzorg flora (1904—1923) has taken the place of the Bryologia Javanica. Important also is V. T. BROTHERUS' work "Musci novi papuani" in ENGLER's Jahrbücher (1893).

An important work on Hepaticae is VAN DE SANDE LACOSTE's "Synopsis Hepaticarum javanicarum" (1856), whilst V. SCHIFFNER edited "Les Hépatiques" (1900), which forms the fourth part of the Buitenzorg flora.

LICHENS were described in "Plantae Junghuhnianae" by C. MONTAGNE and R. B. VAN DEN BOSCH (1856), afterwards by J. MÜLLER in his "Lichenologische Beiträge" 1882 and by HUE in the "Annales" of 1901.

E. DE WILDEMAN's "Prodrome de la Flore algologique des Indes néerlandaises" (1897 et 1899), is an important addition to the knowledge of algae. This work was soon followed by a monograph of Caulerpa published by Mrs. WEBER—VAN BOSSE in the "Annales", which also contain other articles on algae by the same author. In 1900 DE WILDEMAN published "Les Alges, essai d'une flore algologique de Java". Corallinaceae were discussed in 1904 by Mrs. WEBER and M. FOSLIE in the publications of the Siboga-expedition. In the same work Mrs. WEBER published a "Liste des Algues du Siboga" 1913. A separate dissertation published by the Board of agriculture (1908) is CH. BERNARD's detailed study of Javanese Protococcaceae and Desmediaceae.

The fungi were for a considerable time studied with a view to their importance as parasites and the use made of them in technics. The "Annales" contain articles by FISCHER (1876—1887), SOLMS LAUBACH (1887), PENZIG (1899), BERNARD (1906) and HENNINGS (1910) in which new forms of Fungi are described. Among the mycologic studies of our own days may be mentioned those by GÄUMANN: "Mycologische Mitteilungen" I and II in the "Bulletin du Jardin botanique" 1921 and 1922 and by VAN OVEREEM in the "Bulletin" (1922), "Verzeichniss der Myxomyceten, Fungi und Lichenes bis zum Jahre 1920". Van OVEREEM and WEESE started an illustrated work entitled Icones Fungorum Malayensium of

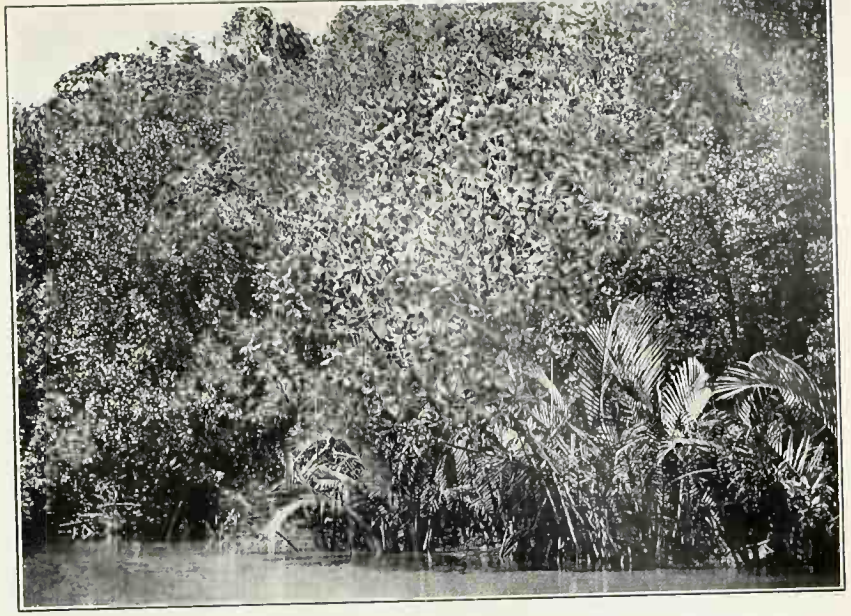
which only 16 parts have appeared in 1923—1926. Another important work by VAN OVEREEM is "Nutzpilze" published in the "Bulletin" 1927.

A study of the Myxomycetes by O. PENZIG was published as the second volume of the Buitenzorg flora (1898).

A few words may be devoted to the dissertations on the genetic phytogeography of the archipelago to which to a certain extent belongs the study of the new flora of Krakatau, mentioned in the first part of this chapter. When TREUB started this study in 1886 the character of it was mainly oecological. The supplementary investigations by PENZIG and ERNST in 1902 and 1907 were both of an oecological and a floristic nature; subsequent investigations by DOCTERS VAN LEEUWEN, which for that matter are not restricted to Krakatau but include the whole group of islands, have not only an oecological-floristic character but are also of importance for plantsuccession. Genetic botanical geography of the high mountains was studied by DOCTERS VAN LEEUWEN "Over de plantengroei van de hoogste bergtoppen van Java" (On the vegetation of the highest mountaintops of Java) 1922 and TH. SCHMUCKER 'Beiträge zur Kenntniss der Hochgebirgsflora Javas und zur Theorie der Pflanzenausbreitung". Of far greater general importance for this part of phytogeography are the articles by H. HALLIER "Die Zusammensetzung und Herkunft der Pflanzendecke Indonesiens", in J. ELBERT's Sunda expedition and by E. D. MERRILL, who discussed the distribution of plants in connection with the geological history of the archipelago in the Proceedings of the Pan-Pacific Science congress of 1923 and who in the same year compared his opinions with the distribution of the Dipterocarpaceae (Philipp. Journ. of Science). The same comparison was made by Dr. H. J. LAM (1927) for the Sapotaceae (Some remarks on the genetic phytogeography of the Malay archipelago, Annales Buitenzorg Vol. 37). whilst C. G. G. J. VAN STEENIS is his study of the Bignoniaceae mentioned above (1927) writes at great length about the problem when he treats the distribution of this family of plants.

Hardly any phytosociological work has been done in our own times either in the Dutch East Indies or elsewhere in the tropics. Special attention must therefore be paid to Dr. J. W. C. KOOPER's exhaustive study: "Sociological and ecological studies on the tropical Weed-vegetation of Pasuruan (the island of Java)", an Utrecht-thesis 1927, which was also published in the „Recueil des travaux botaniques néerlandais" vol. XXIV.

1. Mangrove vegetation, Telok Sekanak, Palembang (Sumatra).



2. Mangrove veg. with Nipa fruticans; Segara Anakan near Tjilatjap (Java).

*Photo J. Jeswiet.*

3. Mangrove vegetation with Sonneratia alba; Kraksaän, Java.

*Photo J. Jeswiet.*

4. Sonneratia acida, the outmost plants of the tidal forest.

*Photo J. Jeswiet.*

5. Tidal forest with Bruguiera gymnorrhiza. Tjilatjap (Java).

*Photo J. Jeswiet.*

6. Carapa obovata in the mangrove vegetation of Tjilatjap (Java). In the foreground the aerial roots of Bruguiera.

*Photo J. Jeswiet.*

7. Sandy shore between Plalaän and Lekok (Java) with Opuntia nigricans, Euphorbia Tirucalli, Zizyphus Jujuba and Tamarindus indica.

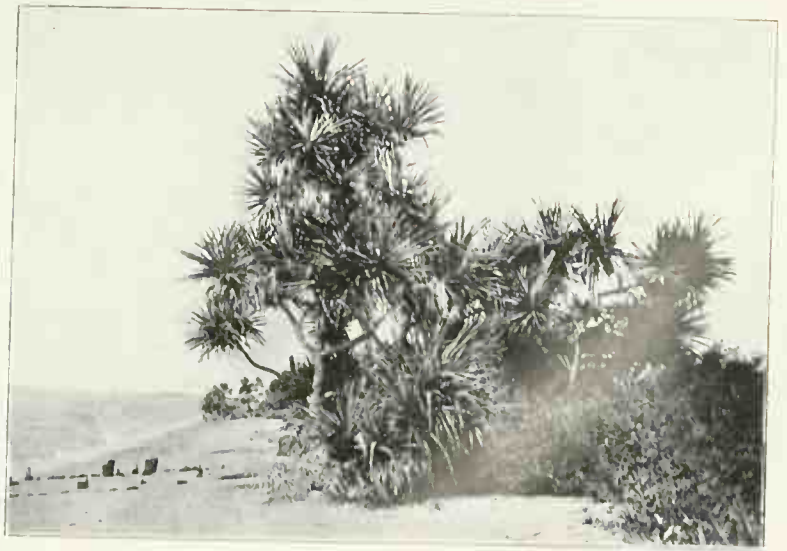


*Photo J. Jeswiet.*

8. Sea shore at the island of Madura, with Pandanus tectorius and Acanthus ilicifolius.

*Photo J. Jeswiet.*

9. Alocasia macrorhiza in secundary woods near Poespa, Java. (1900 feet.)

*Photo J. Jeswiet.*

10. A big specimen of Radermachera gigantea at the Travertine basin "Tjeding" near Blawang.

*Photo J. Jeswiet.*

11. Casuarina montana with undergrowth of Albizzia montana and Alsophila spec. Kawa Idjen, Java (7200 feet).

*Photo J. Jeswiet*

12. A specimen of Acacia leucophloea on Mount Semongkrong, Java.

*Photo J. Jeswiet.*

13. Sanddunes on the island of Madura with Vitex ovata, Calophyllum Inophyllum, Spinifex littorale and young specimens of Corypha Gebanga.

*Photo Hazelhof.*

14. View on a small river near Pasuruan, Java.

*Photo J. Jeswiet.*

15. Albizzia stipulata in grassy plain on the Mount Idjen, Java (5000 feet). On the foreground Andropogon Nardus.

*Photo J. Jeswiet.*

16. Pteridium Aquilinum and Imperata arundinacea, covered with ice at 6.30 a.m. Ngadisari, Java.

*Photo J. Jeswiet.*

17. Sandy plain in the Segora Wedi Lor, covered with tufts of Agrostis and Carex. In the background Casuarina montana.

*Photo J. Jeswiet.*

18. Grassy fields on Mount Semongkrong near Plalaän, Java with Tamarindus indica and Bambusa Blumeana.

*Photo Dr. Coert.*

19. Acrostichetum aureae in salt-marshes in the mountains near Ngantang, Malang, Java.

*Photo A. Salverda.*

20. Old Teak wood (Tectona grandis), Java.

*Photo J. Jeswiet.*

21. Old specimens of Vaccinium varingiifolium in a cleft between Segora Wedi Lor and Segora Wedi Kidoel, Java.

*Photo P. Arens.*

22. Festucetum near the summit of Mount Ardjuno, Java, with Anaphalis javanica, Vaccinium varingiifolium and small specimens of Casuarina montana.

*Photo J. C. Koningsberger.*

23. Summit of Mount Pangerango, Java, with Anaphalis javanica (9200 feet).

*Photo P. Hubrecht.*

24. A specimen of Myrmecodia spec. between shrubs on the summit of Mount Wichmann, Dutch New Guinea (9500 feet).

# THE ANTHROPOLOGY OF THE INDIAN ARCHIPELAGO AND ITS PROBLEMS

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Any one wishing to give an answer to the question: "what do we know at present about the anthropological composition of the native population of the Indian Archipelago?" will find himself confronted by anthropological problems the solution of which will in the opinion of the present writer, have to be attempted first of all in the near future. Of almost every branch of learning, hence also of our knowledge of the various races of the population of the Indian Archipelago, it may be said that what we really know is utterly insignificant in comparison with what we should like to know and hope to be more familiar with in time to come. It goes without saying that this holds good especially for anthropology, a branch of learning which is still in its prime and has on that account been studied as yet by few and during a comparatively short time. The task of the student of anthropology is made more difficult by the fact that from time immemorial new and foreign elements among the population, probably from quite different regions have entered the Indian Archipelago. The newcomers drove the tribes living there away altogether to some other dwellingplace or mingled more or less intensively with the races residing in the Archipelago, in consequence of which the problem of the composition of the various races has become a very intricate one, which is difficult to solve.

Anthropological researches in the archipelago were not begun in real earnest until the latter half of last century. In the "*Journal of the Indian Archipelago and Eastern Asia*", G. Windsor Earl (1849 and 1850) published a kind of anthropological study, a very remarkable and important work, considering the time in which it was written. In this work the author makes some observations interesting and worth considering even in our days, about problems which engross the attention of contemporary anthropologists. Of no less importance was an article by the same author, which appeared in the Journal mentioned above, (1850, vol IV), entitled "The Ethnology of the Indian Archipelago, em-

bracing enquiries into the continental relationships of the Indo-Pacific Islanders", in which among other things attention was drawn to the resemblance existing in many respects between the Papuans of New Guinea and the African negroes, on the strength of which he concluded that there must be a relation between the two races. In another study, which appeared in the same year, entitled "The Ethnology of Eastern Asia" LOGAN says: "the ethnology of the Indian Archipelago and the more eastern parts of Asianesia has, on most sides, a double aspect, one of an African and the other of an Asiatic character. These, however, are frequently so blended, that it is difficult to say, which traits belong to the one and which to the other". CRAWFORD did not at all agree with LOGAN and would not hear of any relation between Papuan and African negroids. He rightly remarked: "In the presentstate of knowledge I fear we must pronounce that the origin of the nations which inhabit the Indian islands seems buried in unfathomable obscurity, and hardly appears less mysterious than that of the indigenous plants and animals of the country they inhabit."

We should not forget, however, and we must observe emphatically that LOGAN's ideas and considerations were mainly based on the comparative study of languages by means of which he hoped to solve the race problem in Insulinde and far less on an accurate and systematic inquiry into the physique, the physical condition of the native population.

Fortunately, however, anthropologists began soon after this to be convinced that the study of the physique might furnish important data for the solution of the problems of the composition of the race and that this study therefore should not be neglected any longer. When the interest in physical-anthropological inquiries had been roused and had become more general, especially by the researches and studies of BLUMENBACH, RETZIUS, PETRUS CAMPER and SANDIFORT, some investigators in the Indies also began to devote their attention to inquiries of this kind. BLEEKER, ARNDT and SWAVING made a minute study of human skeletons obtained from various parts of the Archipelago; their work was afterwards continued especially by A. B. MEYER, RUDOLPH VIRCHOW and the Russian traveller and anthropologist VON MICKLUCHO-MACLAY. They were convinced already that not only dead things, human skeletons, ought to be studied to solve the race problem, but that the study on a larger scale of living beings might tend to increase our knowledge and give us a better insight into the question. The great scientific expeditions in the closing years of last century, but especially those of the first years of the present century have led to these studies. These expeditions were partly undertaken under the auspices of the great scientific societies in Holland and in the Indies. They have enriched our anthro-

pological knowledge considerably. Mention must be made here of the scientific expedition through Borneo, undertaken by Dr. A. W. NIEUWENHUIS, the expeditions of the SARASIN's in Celebes, of RUDOLPH MARTIN in the Malacca peninsula, the expedition of Dr. ALFRED MAASS and KLEIWEG DE ZWAAN through Central Sumatra and Dr. TEN KATE's numerous scientific journeys in the Archipelago. Nor must the different important expeditions in New Guinea be forgotten, on which anthropological investigations were made by KOCH, VAN NOUHUYS, VAN DER SANDE, BIJLMER, WIRZ, NEUHAUSS, SCHLAGINHAUFEN, PÖCH, RIVERS, SELIGMANN, HADDON, WOLLASTON, ROBERTSON, WILLIAMSON and others. Besides these, more local anthropological investigations were made in the smaller islands e.g. in Mentawei (MAASS, VON LUSCHAN, VOLZ), Kissar (RODENWALDT), Nias (KLEIWEG DE ZWAAN), Bali (KOCH), Java (KOHLBRUGGE, KOCH) and also in the Philippines.

In spite of all these and several other investigations, however, our anthropological knowledge of the population of the Indian Archipelago is but very fragmentary and absolutely inadequate. Several regions have not been investigated at all or at best but perfunctorily and not infrequently the investigators were people not versed in this kind of work. This again was mainly caused by the fact that no anthropology was taught in our universities so that the students never heard anything about the way in which these investigations had to be made.

Any one wishing to make an anthropological map of the Indian Archipelago to-day, would have to mark very extensive regions as terra incognita.

Let us now see what view anthropologists take at present of the composition of the races in the Indian Archipelago. According to some the native population consists principally of four different layers which entered the Archipelago one after another. These four race-elements are:

I. The Negrito element.
II. The Wedda element.
III. The Ur-Malays (Prae-Malays, Indonesians).
IV. The Malays proper (deutero-Malays).

It need hardly be said that besides these four elements numerous other peoples have in the course of time settled in the Archipelago; some of these are Europeans, Chinese, Japanese, Arabs, Hindoos etc., these have partly crossed with the native population which has contributed more or less to bring about a modification of the original type.

I. The Negrito element.

Very likely this is one of the oldest elements of the population of the Archipelago; it has been found with the slightest admixture of other

races in the Malacca peninsula (the Sémang and Panggang) and in the Philippines (the Aeta). Related to these tribes are the Mincopies of the Andaman islands.

These peoples are not improbably the last remnants of an old South-Asian race-element. The characteristic physical qualities of these Negritos are: a very short stature, a very dark skin, crisp hair, black-brown eyes, a very broad nose, projecting jaws and a brachycephalic skull.

With respect to this Negrito element some important problems arise, about which anthropologists do not agree and which cannot be solved without a further and closer investigation:

1. Is this Negrito-element also found in other parts of the Archipelago than in the Malacca peninsula and the Philippines?

2. Are the results of the investigation to determine the physical qualities characteristic of the Negritos absolutely reliable and are they exactly the same for the various Negrito-peoples?

3. Are the Negritos of the Andaman islands, the Philippines and the Malacca peninsula related to the short-statured Negroid peoples in New Guinea and are they also related to the Negroid pygmies of Africa?

4. Where has the Negrito-element in the Indian Archipelago come from and at what time did the immigration take place?

5. What is the relation between the Negrito-element and the Wadjak-element in Java?

1. Do the Negritos live in other parts of the archipelago than those mentioned above?

Some anthropologists are of opinion that the Negrito element has also contributed to build up the population in other parts of the Archipelago, e.g. in Borneo (Hamy), in Java (A. B. Meyer, Gigliogi) and Sumatra. Others again believe they have recognised this element also in Celebes, Timor, Flores, Lomblen, Adonara, Sumba, Buru, Ceram, Pantar, Sumbawa and Djilolo. On the other hand other investigators are of opinion that the Negrito element has acted its part only in the Philippines and in the Malacca peninsula. I myself have not been able to find this element either in Sumatra or in Nias. In Moszkowski's „Auf neuer Wegen durch Sumatra", however, we find the picture of a decidedly striking Negrito-type. Photos of Javanese, sent to me by Dr. E. J. Bok almost make me feel convinced that the Negrito element forms an essential part of the population of Java.

There is also some uncertainty and difference of opinion about the question where the Negrito element is found outside the Indian Archipelago. There are anthropologists who look upon this element as a more or less important element in the population of British India,

Ceylon, South China, Formosa, Cambodja, Siam, Annam and even of Japan. Others, however, deny this emphatically. Further investigations also in these regions are therefore very desirable.

It would seem that we may assume that both in the Philippines and in the Malay peninsula the Negritos have been partly exterminated by peoples who invaded those regions in after times and have been partly driven more and more to the interior, whilst partly also they have more or less intensively become mixed with these later invaders. In the Philippines they are nowadays found principally in the two large isles of Luzon and Mindanao, also in Palawan. NEWTON, however, thinks that the number of real Negritos there does not exceed 5000.

Investigations about the Negritos of the Malacca peninsula have been made especially by RUDOLPH MARTIN, SKEAT and BLAGDEN.

It cannot be denied, however, especially with regard to the investigations in the Philippines that in several cases the material examined was either too scanty or the investigations themselves were not made correctly. This holds good not only for the measurements of living people but also for the examination of the size and configuration of the skull and of the rest of the skeleton.

2. Are the results of the investigations to determine the physical qualities characteristic of the Negritos absolutely reliable?

In this respect, too, we must say that we cannot be absolutely certain about the correctness of the investigation on account of and in consequence of the comparatively scanty material observed. Is it for example quite certain that the Negritos are brachycephalic? GRIFFITH TAYLOR doubts this. The average index cephalicus for the Sĕmang of Malacca is given as only 78—79 i.e. They are not brachycephalic but mesocephalic. Besides the average stature given for the Sĕmang (152 c.M.) is greater than that which has been taken to be characteristic of the Negritos. IVOR EVANS has given the principal sizes of the skulls for a small number of Negritos in Siam, which are also given for the Siamese Ngok, Ngok Pa, Chao Pa or Kuan Pa. These Negritos call themselves Monik. The index cephalicus varied between 76.3 and 81.1; the average index was 78.8, consequently we have here mesocephalic and not brachycephalic skulls. In his dissertation BIJLMER also points to the desirability of an anthropological investigation on a larger scale of the various Negrito-tribes, because our knowledge of the physical qualities of these various tribes is doubtless very inadequate. It would seem that the wavy hair which is not infrequently found among the Negritos must be attributed to the fact that they have interbred with other race-elements. Several of the specimens occurring in MORICE VAN OVERBERGH's article "Negritos of Northern Luzon" (Anthropos

Vol. XX, 1925, Heft 3/4) appeared to have wavy hair and were of a distinct Wedda-type. The Malay-type, too, could be easily recognised among these photos.

3. Are the Negrito tribes of the Andaman islands, of the Philippines and of the Malacca peninsula related to the Negrito-tribes of very short stature in New Guinea and are they also related to the pygmies of Africa?

There is a good deal of uncertainty about this problem and much has been written about it. There are anthropologists who maintain that all these pygmies (if at least they are pygmies all of them, which is not yet quite certain) are related to each other and that they represent the remnants of one primitive ur-race, from which the many peoples of much taller stature are supposed to have originated in the course of time. Others on the other hand deny this mutual relationship and to support their conception they call attention to the important bodily difference between these tribes, which were found to exist e.g. in the shape of the head, the colour of the skin, the proportions of the body, the shape of the upperlip, etc. The New Guinea pygmies e.g. are said to be less brachycephalic and their head is larger than that of the Negritos of the Philippines, of the Andaman islands and the Malay peninsula. Besides these, it is said that there are differences in the shape of the ear, the nose and the lips. How are these differences to be explained? Are they caused by cross-breeding or do they point to a different race? It is no wonder therefore that some anthropologists are of opinion that the New Guinea pygmies are not real Negritos, but simply Papuans or Melanesians of short stature, distinguished from the other Papuan and Melanesian tribes in that they are of shorter stature and are less dolichocephalic. BIJLMER does not look upon the pygmies of New Guinea as a separate and special race-element, but considers them to be tribes consisting of the same elements as the other Papuan-tribes of New Guinea. He supposes that the Negrito element is only more predominant among these pygmies than among the other Papuans. A. C. HADDON, WILLIAMSON and STRONG take pretty much the same view. HADDON's opinion is that the Mimika pygmies in Dutch New Guinea and the other pygmy tribes there, related to them, are Negritos or Negrito-tribes, interbred with Papuan blood. BIJLMER, however, thinks that Negrito blood is also found in the Papuan tribes of tall stature, though to a less extent than in the pygmy tribes of New Guinea.

VON EICKSTEDT has examined the skeleton of a real Negrito down to the minutest details and compared it with the Pěsěchěm skeleton from New Guinea. The two skeletons appeared to have certain special characteristics in common, which might point to a primitive build of

these tribes and which are probably characteristic of a primitive stage in the development of mankind. In many respects, however, these skeletons showed such utterly different qualities e.g. in the form of the face, in the proportions of the body and others, that he could not possibly assume any relationship between them. Hence he looks upon the various negroid tribes of a very short stature as variants of the Negritic peoples originated in different regions and at different times. This conception has much in common with that of SARASIN. The latter looks upon the pygmy tribes as neotene forms, as tribes which have in certain respects preserved qualities of the body, characteristic of children, not of grown ups.

HALFDAN BRYN is of opinion that the pygmy tribes of our own days are very small remnants (not of the same race however) of a number of pygmy variants which were much more numerous in former times. According to HALFDAN BRYN there are no relations between the various pygmy groups.

It is to be expected that a better insight into this most important problem, about which opinions differ so considerably will only be gained when anthropological investigations among these pygmies have been made on a larger scale. Up to the present only a few tens of these pygmies have been measured. This number of course is utterly inadequate, with such a small quantity undue importance will no doubt be attached to individual values and individual varieties. It is also most desirable that future investigation in New Guinea should pay special attention to the semitic type, which is so often found among the Papuans and which is frequently so strongly marked. What does this peculiar type mean and from where has it come? This is another interesting problem. I believe that elsewhere in the archipelago, viz: in Celebes a semitic type has also attracted attention.

4. Where has the Negrito element in the Indian Archipelago come from and what was the time of the immigration?

The answer to this question must be again that there is no certainty about it. It is very probable, however, that it has come from the Asiatic continent. It has been thought possible that the whole of the Oceanic regions, inhabited by Negritos nowadays, was formerly in some way connected with the Asiatic continent and that the Negritos entered the Archipelago in this way. I do not dare to say whether this was possible; this is a problem the solution of which must be left to geologists.

Another theory — which in the opinion of the present writer is more plausible — is that the Negritos have in the course of time crossed from one group of islands to another. It goes without saying that to

solve the problem of the origin of the Negrito element, a careful anthropological study must be made, especially of the neighbouring tribes of the Asiatic continent. We know very little about them; investigators have only quite recently begun to pay attention to them. REED has therefore very properly observed that it is really quite uncertain from where the Negritos have come. Have they come from Asia, from some island, e.g. New Guinea or from some region now submerged? We do not know.

5. What is the relation between the Negrito element to the Wadjakman of Java?

We called the Negrito element one of the oldest of the Indian Archipelago. It seems pretty certain, however, that the Wadjakman forms a still older element of the population. DUBOIS is of opinion that the dolichocephalic Wadjak-skulls date from the pleistocene. It would seem that we may safely say that no relation exists between the Negritos and the Wadjak, for the Wadjak skull differs too much from the Negrito skull, both in its dimensions and in its shape.

The Wadjak skull is more like the skulls of Australians or Tasmanians and also, though to a less extent like that of the Papuans. DUBOIS believes that the Wadjakman is the ancestor from which the peoples mentioned above have originated through degeneration under the influence of unsuitable surroundings and unfavourable circumstances. It is a matter of great importance that very probably this common ancestor had its origin in Asia. In the opinion of the present writer the Wadjakman is related to the Wedda type rather than to the Negrito element; the former has also played its part in the building up of the native population in the Dutch East Indies. It is to be hoped that through new finds of fossil skeleton-material more material will be available for comparison.

We must not forget to make mention of the fact that near Manilla SANCHEZ Y SANCHEZ found not long ago a human skull, which in his opinion is of prehistoric origin and which is said to resemble the Negrito skulls found in the grottos in the Philippines. This skull may not improbably point to a very old race, short of stature, which was subbrachycephalic, strongly prognatic, very platyrhine, with slightly protruding arcus supraorbitales and a slightly receding forehead. SANCHEZ believes that this type is the precursor of the Negritogroups of our days. If this should really be so, it would point to the fact that the Negrito element had settled in these regions in times long past. It is not certain, however, from when this skull dates, which without doubt considerably lessens its importance. Judging from the description of this skull, however, it is hardly possible to assume any relationship to the Wadjakman.

II. The Wedda element in the Indian Archipelago.

This element of the population has been studied by SARASIN, RUDOLPH MARTIN, SKEAT and BLAGDEN. SARASIN thinks he has discovered the remnant of an ur-population in the Toala of Lamontjong in South Celebes. This tribe is short of stature, has a dark skin, wavy hair, a deep lying root of the nose and according to SARASIN shows a close resemblance to the Wedda studied by him in Ceylon. He found tribes related to the Toala also in the South Eastern peninsula of Celebes, viz: the Tomuna and Tokea and besides these, the slaves and families of slaves in Central Celebes are said to be of the same type. It is true that the index cephalicus of these tribes (81.7) was found to be higher than has on an average been found with the Wedda, who are distinctly dolichocephalic. SARASIN is of opinion, however, that in spite of the preponderance of strongly marked brachycephalic forms, the Toala are a tribe characterised by moderate mesocephaly. The skin of the Toala tribes was found to be a little lighter than that of the Wedda and there is also a difference in the proportions of the body. The tools and instruments found in the caverns formerly inhabited by the Toala of a bygone period point — according to SARASIN — to a civilization which forms a transition from the Magdalénien to the neolithic period: it was a mesolithic civilization of a type resembling the European Azilien — Tardénoisien. In this connection it is worth remarking that near Ponorogo in Java the engineer VAN ES has discovered a civilization in a limestone-grotto, which also resembles the European Azilien in many respects.

Another centre of these Wedda-like tribes in the Indian Archipelago has been found in the Malay peninsula, where RUDOLPH MARTIN became acquainted with the so-called Orang Senoi and Orang Sakai, a type which shows a striking resemblance to the Wedda of Ceylon and differs greatly from the Negritic Sĕmangs living there, both by the wavy hair and by a longer skull, taller stature and a lighter skin. Yet it appeared that there were bodily differences between these Senoi and Sakai on the one hand and the Wedda on the other, which are strongly marked e.g. in the proportions of the body. But these Senoi and Sakai did not resemble the Toala of Celebes either, in every respect. They slightly differed from the latter in the form and measurements of the head. Dolichocephalic and mesocephalic forms of the head were found more frequently than with the Toala, whilst the arcus supraorbitales of the Senoi are less protruding than with the Toala and certainly ever less so than with the Wedda of Ceylon.

Though without doubt a remarkable resemblance was found to exist between the three peoples mentioned, Wedda, Senoi and Toala, yet

we should not forget that bodily differences have been found as well. What is the meaning of this difference? It must also be remembered that SARASIN examined only a pretty small number of men. It is therefore desirable to make a closer investigation on a larger scale to examine the mutual relations between these tribes.

Another important problem is the following: has the Wedda-element also played a part elsewhere in the Indian Archipelago in the upbuilding and composition of the native population? Very little is known with certainty about this. I for me am inclined to assume that also in other places in the Archipelago this Wedda element forms part of the population, though it has in those parts more or less intensively interbred with the other elements of the population. In Sumatra, in Nias and in Java I have several times seen types which closely resembled the Wedda of Ceylon. HERMAN TEN KATE fancies that the Wedda type in the Indian Archipelago was at one time spread over a considerably larger area than is generally assumed. His opinion is that he has not infrequently met this type in the Sumba islands and he believes that the influence of a Wedda-like ur-race can be traced among the tribes of the Mentawei islands, in Nias, among the Battaks, Dyaks and several other tribes in the Archipelago. It is also believed that Wedda characteristics have been observed in the Orang Sakai and the Kubus of Sumatra; also in Banka, Biliton, in several islands to the east of Java and even in New Guinea. According to SARASIN the Wedda element might even be assumed to constitute an element of the population in Borneo. This is not quite certain, however, and anthropologists will have to make a closer investigation of this problem in times to come. For instance, are the wavy-haired types observed in the Geelvinkbay people belonging to the Wedda type or are they, as NEUHAUS thought, a cross between Papuans and Malays, crisphaired Papuans, whose hair has become wavy as a consequence of cross breeding with smooth-haired Malays? This is indeed an interesting problem both for the anthropologist and for the geneticus.

It seems that we may take it for granted that this Wedda element in the Archipelago has come from South-East Asia. An argument in favour of this is that in Song-Be and in the Bas Laos district MOLBÉ has come across types which in my opinion belong to the Wedda type. I have also found pictures of a distinct Wedda type in the work by FAY COOPER, about the Finguyans of N. W. Luzon, which appeared some years ago. Wavy hair is pretty frequent with the Finguyans, the Ilocano, the Apayao and the Igorots. All this points to the probability that the Wedda element found its way into the Archipelago from the part of South East Asia mentioned above, via the Malacca peninsula and the Philippines.

The relations existing between the Wedda and the Australians form also a very important problem. Bylmer supposes that the Papuans of New Guinea may owe their physical characteristics partly to a Dravido-Wedda-Australoid element, which moved in an easterly direction from India as far as Australia. Sarasin has declared emphatically that the dolichocephalic Wadjak skulls found by Dubois may give important indications about the problem of the origin and the extension of the Austro-Melanesian group. Sarasin still thinks it very probable that there is some relationship between the Dravida of British India and the Australians, others look upon this relationship as only a local phase of the development of the Wedda type. In his well-known work "Die Wedda's von Ceylon und die sie umgebenden Völkerschaften" Sarasin has already said that the Australians represent a curiously changed variety of the Dravida, an opinion which he has worked out more fully in his later work "Die Anthropologie der Neu-Caledonier und Loyalty-Insulaner".

III. The Ur-Malays (Indonesians).

But very few data are available to enable us to form an idea of the significance of this race-element for the composition of the population of the Indian archipelago and the spread of this element over this island empire.

On his travels through Borneo Nieuwenhuis not only came across brachycephalic Dyaktribes but he also found some tribes which were dolichocephalic. The Ulu Ajar Dyaks along the river Mandai are distinguished from the other Dyak tribes not only by their dolichocephaly but also by their shorter stature, darker skin, broader and at the same time concave nose and broader mouth. Kohlbrugge, who has studied the anthropological material collected by Nieuwenhuis, has found that besides the Ulu-Ajar-Dyaks mentioned above, also the Suru- and Mahakam-Dyaks are dolichocephalic. Kohlbrugge thinks that this dolichocephalic group belongs to the Ur-Malays, in contradistinction to the Malays living along the coast, who are brachycephalic. Afterwards distinctly dolichocephalic Dyak tribes have also been found in Sĕrawak. Hose and Mc Dougall are of opinion that this element has come to Borneo from South East Asia. At one time Kohlbrugge thought that the Tenggerese in Java might also be looked upon as Ur-Malays; afterwards, however, he tried to find another explanation for the dolichocephaly of these people. Ten Kate believes that the race of the Ur-Malays has also played a part in the formation of the tribes in Mentawei, Nias, the Battaks and other tribes in the Archipelago.

It is certainly most remarkable that out of a number of 8 Mentawei skulls examined by me, 3 appeared to be dolichocephalic, 4 meso-

cephalic and but 1 brachycephalic, whilst out of a number of 100 Nias-skulls of which I knew the measurements no less than 44.8 % were dolichocephalic, 34.4 % mesocephalic and but 20.8 % brachycephalic. A pretty considerable percentage of dolichocephalic people have also been found in numerous other islands in the Archipelago e.g. in the Moluccas, in Ceram, Buru, Timor, Tanimbar, Sumba, Rotti, Savu, Solor and others.

The problem now to be solved is which race is characterised by this dolichocephaly, the ur-Malays, the Wedda element or a Papuan population? The solution of this problem requires a closer investigation. SULLIVAN believes that several tribes in the Philippines which are distinguished from the neighbouring tribes in these islands by a somewhat longer head, must be looked upon as Ur-Malays. SARASIN on the other hand does not dare to consider this dolichocephaly as characteristic of the Ur-Malays; we can only say, according to him, that upon the whole these tribes are characterised by a mesocephalic skull, in contradistinction to the mixed-Malay tribes whose skull is more or less distinctly brachycephalic. Besides SARASIN maintains that in the stature and the colour of the skin there is no essential difference either between the Ur-Malays (Indonesians) and the Malays. Consequently SARASIN dare not look upon these Ur-Malays as a separate race-element different from the Malays proper, but rather subdivides the substratum of Malay population into a proto or pure Malay stratum and a deutero- or mixed Malay stratum. He includes among the latter all Malays living along the coasts in the Indian archipelago and the mixed tribes there, also the Javanese. He looks upon Farther India as the birthplace of the proto-Malay stratum and thinks that it is from there that these peoples have entered the Indian Archipelago. It cannot with certainty be said when this immigration took place, but it would seem that it was after the invasion of the Negrito and the Wedda group.

We must not omit to say that among a great number of Ceram skulls MARGARETE KAPP-SCHWOERER has found several which must probably be looked upon as belonging to the proto-Malay element, whereas others showing a close resemblance to my Nias-skulls, do not improbably belong to the deutero-Malay stratum. I myself have found that a number of Tanimbar skulls resemble the Nias-skulls in many respects.

IV. The Malays proper, SARASIN's deutero Malays, who according to him form a more or less mixed element of the population in contradistinction to the proto-Malays also seem to have come to the Archipelago from the Asiatic continent. It is possible that before they left Asia they had in no small measure mixed with Mongolian elements, which process

may have been continued in the Archipelago itself. These Malays are rather short of stature, they have smooth hair, a broad face, a broad and flat nose, dark eyes, alveolar prognathy and a brachycephalic skull.

A Mongoloid fold near of the eye is pretty frequent. In Java, however, and also more or less elsewhere, these Malays have interbred especially with Hindoo-elements. In this way the delicate, aristocratic Javanese type of the "Vorstenlanden" has come into being.

We have seen that especially the remnants of the prehistoric human skeleton can give us important indications about the movement and spread of race elements in times of yore. In this connection it is noteworthy that a skull of the Negrito-type has been discovered in a neolithic stratum in a cavern of Minh-Cam in Annam. Very probably, however, the Negrito element resided in Indo China before this and consequently also arrived in the Indian archipelago at a very early date.

It is evident that also remnants of civilization, tools and instruments from prehistoric times may give us important indications to fix the date of this migration. Researches with respect to this problem were not begun until quite recently, but fortunately the results of this inquiry have been very satisfactory and have led to many conclusions. Of late years Ivor Evans, Gordon, Thomson and Van Stein Callenfels have discovered stone tools of an early palaeolithic character in the Malacca peninsula and in Sumatra. Similar tools, however, have also been found in Indo China. It has been found that the lithic civilizations of Indo China, of the Malay peninsula and Sumatra resemble each other in many respects. Van Stein Callenfels thinks that the palaeo-protoneolithic civilization of Indo China (what the French call the bacsonian) spread in two waves over the Malay peninsula and partly beyond this. The older of these, which was most primitive, had only palaeolithic tools and did not know the art of making earthen pots and vessels, reached Sumatra; the younger, on the other hand, which developed the so-called proto-neoliths and had pottery at least in its later strata, reached no farther than the Malacca peninsula.

Van Stein Callenfels thinks that the neolithicum proper in the Indian Archipelago can be divided into 4 different periods, each of which is characterised by a distinct type of ground stone axe. These four phases of civilization seem to have spread pretty regularly over a considerable part of South-East Asia. It would seem that there came a separation at the end of the fourth period, caused by the fact that the large area split up into two provinces, each of which developed a very distinct type of tool. The northern province comprised Indo China, Siam and Burma and produced the so-called shouldered axe. In a Westerly direction this area extended as far as the Ganges plain,

and in an easterly direction as far as Formosa and Japan. The other, the Malay province, comprising the southern half of Sumatra, also Java and Bali, produced the pointed axe. The boundary between the two provinces, must according to VAN STEIN CALLENFELS have been somewhere in the Malacca peninsula. The beginning of the fourth period of the Neolithicum in the Indian Archipelago may in his opinion be fixed at 2000 B. C., and inasmuch as this fourth period was preceded by three others, we might fix the beginning of the full neolithic period in South East Asia at about 3500—4000 B. C.

In spite of the prevailing opinion that the Malays, the Javanese and others have migrated to the Archipelago only a few hundreds of years before the commencement of our era, VAN STEIN CALLENFELS believes he may assume on the strength of his prehistoric discoveries that this migration took place as early as ± 2000—1500 B. C. He thinks that the date of the palaeolithic civilization in Sumatra may be fixed at ± 3500 B. C. A closer investigation, we hope, will teach us what were the peoples of these earliest civilizations. It would seem, however, that on the East coast of Sumatra the palaeolithic civilization prevailed a very long time and that there the palaeolithic period immediately passed into the metal age.

In this connection it is worth observing that a civilization resembling the European late palaeolithicum was unknown, it seems, also in Western Asia and in North Africa and that there the early palaeolithic civilization passed at once into a neolithic. In these parts therefore the early-palaeolithic civilization was pre-neolithic. BAYER calls it the Askalon-civilization. It would seem therefore that a real early-palaeolithic civilization existed only in Europe and that in this part of the world the late palaeolithic civilization takes a position between the early-palaeolithic period and the neolithic civilization. It seems that in Asia and North Africa this late-palaeolithic civilization is unknown.

It is not improbable that also the examination of blood-groups may be useful to our knowledge of the race-composition in the Indian Archipelago. BAIS and VERHOEF have found that among the Sumatrans 43.7 % of the people examined belongs to bloodgroup I; 23 % belongs to group II; 29 % to group III and 4.3 % to group IV. The biochemical race index was 0.82. For the Javanese the following results were obtained: blood-group I — 39.9 %; II — 25.7 %; III — 29.0 % and IV — 5.4 %. Index 0.9. For the Chinese of Sumatra: I — 40.2 %; II — 25 %; III — 27.6 % and IV — 7.2 %. Index 0.92. For the Klingalese: I — 37.9 %; II — 23.0 %; III — 31.6 %; IV — 7.5 %. Index 0.78.

BAIS and VERHOEF believe that they may conclude that starting from British India in an easterly direction (China) and in a direction

to the South East (the East Indian Archipelago), the biochemical raceindex increases as one gets further and further away from the starting-point. They found a biochemical index of 0.55 for a number of Klingalese from the coasts of Malabar and Coromandel. This corresponds to the index of 0.56 which HIRSZFELD gives for the British Indians.

LEHMANN obtained for the Bugis (217) in Celebes the following results: I — 34.6 %, II — 30.4 %, III = 27.6 %, IV — 7.4 %; biochemical index — 1.08; for the Makassars in Celebes (195): I = 28.7 %, II — 29.7 %, III — 30.8 %, IV — 10.8 %; biochemical index — 0.97.

It is certainly remarkable that the division of the bloodgroups of the Philipinos in the Philippines differs so much from that of the other peoples in the Indian Archipelago. The following percentages have been found for this people: I — 64.7 %; II — 14.7 %; III — 19 %; IV — 1 %.

But only a small number of these people (204) has been examined; it is necessary to prove the correctness of the results found, by an examination on a larger scale. Upon the whole it is desirable that more attention should be paid to such tests in the Netherlands East Indies.

Prof. ERNST RODENWALDT's book "Die Mestizen auf Kisar", which appeared recently must certainly be looked upon as a work of great anthropological importance for it gives us a good insight into the way in which certain physical qualities may be inherited when different races interbred. The population of the Indian Archipelago offers indeed a very valuable material for such researches. It would doubtless be a matter of great scientific importance to examine also in other parts of the Archipelago the physical qualities and the way in which they are inherited when natives and Europeans interbred. We hope and expect that these subjects will be diligently studied before long.

It is an undeniable fact that also in the Netherlands East Indies students have begun to take an interest in anthropological researches and it is with great joy that I mention this. The foundation of the "Indisch Nationaal Bureau voor Anthropologie", as a sister society of the "Nederlandsch Nationaal Bureau voor Anthropologie", with which it cooperates is a proof of the interest taken in anthropology in the Netherlands East Indies. Great things may still be expected so far as anthropological researches are concerned of BAIS, BIJLMER, ELSHOUT, MIJSBERG, NYÊSSEN, RODENWALDT, VAN STEIN CALLENFELS, VERHOEF and VAN VOGELPOEL, all of them living in the Netherlands East Indies. And I feel sure that their example will be followed by others.

# MEDICAL SCIENCE

by Dr. P. C. FLU,

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Even the very first Dutch navigators and colonists, who travelled to the Dutch Indies, were accompanied by surgeons and physicians. Especially the latter soon had an open eye for the great many things they saw in the tropics with reference to the medical and natural sciences. As far as was possible in those times they made observations which they committed to paper. Many diseases unknown in their own country were studied and described by them.

The historic development of medical research in the Dutch Indies was a subject already written about in the publication of the I. C. O. committee "The History and present state of scientific medical research in the Dutch Indies" (1926), and more detailed in L. D. U. M. VAN ROMER's Historic Sketches, which were also translated into English.

Now the discussion will be limited to the institutions which are at present in existence, and to researches made and results obtained at those institutions, although something has already been said on these subjects in the above mentioned publication of the I. C. O. committee.

In the Dutch East Indies, specially in Weltevreden and Medan, but also in many other towns, the medical profession is well represented and receives much interest. The number of medical men in the Dutch Indies amounts to about 800; among these ± 500 are doctors who were wholly or partly trained at one of the European, mostly naturally Dutch universities, and who are at any rate in possession of a Dutch Doctor's certificate. Then there are ± 300 physicians who were trained at one of the medical colleges in Weltevreden or in Surabaja.

Up to 1927 a training for the medical profession in the Dutch Indies was only possible at the School for Indian doctors at Weltevreden, the so-called Stovia, and at the Dutch Indian School for physicians at Surabaja, the so-called Nias. In August 1927 the Medical University at Weltevreden was established. This university has been appointed

entirely after the example of the home-universities, except for a few alterations which were imperative owing to special Indian conditions. The buildings of the University were obtained by making use of the accomodation supplied by the Stovia which was closed at the installation of the medical university.

About the middle of last century, more especially in 1844, the first medical periodical was published by the name of "*het Natuur en Geneeskundig Archief*" under the able editorship of BLEEKER, the great ichthyologist. But when BLEEKER was transferred to Semarang, e.g. three and a half years after the appearance of the first number of the Archives, the periodical ceased to exist.

In 1851 BLEEKER returned to Weltevreden and founded the Medical Association. This association at once published a periodical "*Het Geneeskundig Tijdschrift voor Nederlandsch Indië*" (The medical journal for the Dutch Indies) which has been appearing regularly up to the present, and which has remained the principal periodical in connection with scientific medical research published in Java.

The publications naturally appear in the Dutch language, but many contributors add a short summary of their articles in a foreign language, whether in German, French or English. Articles in foreign languages are always accepted when presented for publication; provided this is justified by their contents. The "*Geneeskundig Tijdschrift voor Nederlandsch Indië*" appears six times a year, and yearly forms a book of 500 to 700 pages.

Besides this periodical the "*Mededeelingen van den dienst der Volksgezondheid*" (The communications of the Public Health Department) also appear in the Dutch Indies.

These communications were first published in 1912—1913 as communications of the "Burgerlijke Geneeskundige Dienst" (Board of Health) and immediately in Dutch as well as in foreign language (German, French and English). When later the "Burgerlijke Geneeskundige Dienst" (Board of Health) was changed into the "Dienst der Volksgezondheid" (Public Health Department) the name of the publications was altered too. Up to the present 13 editions of these communications have appeared. They contain the results of the researches made by physicians and naturalists who are appointed to the Public Health Department. Many articles published by these research workers in the "*Geneeskundig Tijdschrift voor Nederlandsch Indië*" are translated into a foreign language, and published in full in the publications, by means of which they are also of use to foreigners.

Beside these periodicals there are a few minor ones e.g. the "*Bulletins van den Bond van Geneesheeren in Nederlandsch Indië* (The Bulletins of the Bond of Physicians in the Dutch Indies); the publications of the bond of Indian physicians and "*Het Geneeskundig Tijdschrift voor Indische Artsen*" (the medical journal for Indian Physicians).

In Weltevreden there are excellent medical libraries. In the first place be mentioned the library of the Military Hospital. Here are to be found most of the complete series of the principal periodicals on clinical subjects. There are moreover periodicals dealing with the more scientific and theoretical subjects, such as physiology, anatomy, pathological anatomy, hygiene, bacteriology. Besides these periodicals there are to be found a great number of text-books and manuals on every branch of medical science, publications about all that is known with reference to the medical sciences in the Dutch Indies and the neighbouring Eastern countries, and a wealth of other valuable literature.

The beautiful library of the medical laboratory at Weltevreden is more specially equiped with a view to work done in the more purely bacteriological, parasitological and hygienic sphere, but it also contains a great number of books and extensive literature on physiology and physiological chemistry.

Beside these libraries the Public Health Department possesses in its headquarters at Parapattan a vast library containing especially literature on social hygiene, sanitary law, the quarantine system, etc.

At Bandung the Institute Pasteur also possesses an excellent library, while the Head Office of the Miltitary Royal Army Medical Corps at the same place is in possession of a vast library on medical science as well.

The Medical Association has been of great importance to the development of the medical sciences in the Netherlands Indies. In the first place by means of the periodical which is published by it and which enables medical men to exchange views on medical subjects. The fact that sub-divisions and so-called medical societies ("kringen") were formed was of not less importance. Here physicians gathered together at appointed times, here they delivered lectures and discussed important scientific and practical problems.

In the beginning of this century the Director of the Medical Laboratory at Weltevreden put new life into the Medical society at Weltevreden. This division, the only one which at that time had grown

to importance, became very prosperous. Later, especially after 1906 the society at Medan became as important. One need but cast a glance at the reports of the meetings of the clubs at Weltevreden and Medan to be absolutely convinced of the great significance of these club-meetings for the advance of the medical study in the Dutch Indies.

Recently the clubs at Surabaja and Bandung are also gaining in importance; this is the case at Surabaja because the „Nederlandsch Indische Artsenschool" (Dutch Indian medical college) with its staff of scientific masters can provide the necessary material for the meetings, while at Bandung the same is done by the scientific workers of the "Institut Pasteur" and the professor in hygiene at the Technical University at Bandung, ensuring therewith a lively interest in the more scientific aspects of the medical study.

As was already mentioned in the report of the I.C.O. committee the supervision and the maintenance of the laws and institutions with reference to the public health in the Dutch Indies is entrusted to the care of the Public Health Department. This Department was established in 1910 by the name of "Burgerlijke Geneeskundige Dienst" (Board of Health). Soon it was called to the heavy task to combat the plague which had broken out in the East of Java. This new branch of Service acquitted itself excellently of its task, thanks to the diligence and enthusiasm of the sub-director of the Department, later Chief-Inspector of Public Health Dr. W. Th. de Vogel.

In order to minimize the number of victims, caused by rat plague, which was prevalent in the country, he applied the system of evacuation. Following the example of the Hindus in British India, a dessa (village) or a quarter of the town, where cases of plague among people occurred, or where rats were found which had died of plague, was evacuated.

The people who were forced to leave their houses, in which the danger for infection was great, as had been fully born out by investigation and experience, were accommodated in emergency sheds. Here they had to remain at least a month, sometimes even longer. During the evacuation period the fleas died owing to lack of food, and the population of rats, depleted by the plague, re-established itself, in consequence of which the danger for the people to be bitten by hungry ratfleas, and to be in that way infected with plague was reduced to naught.

It is a pity that this method, which experience has shown to be the only one by which the number of plague cases among people can be with certainty and speedily reduced, has been abandoned in consequence of difficulties met with in its application.

Later the Department adopted the method of fumigating the houses in which cases of plague had occurred among the people. By doing so it was assumed that it would be possible to kill rats as well as fleas in a house which had been locked as well as possible and in which $SO_2$ had been introduced. Laboratory experiments had proved that fleas as well as rats were quickly killed by 3 % $SO_2$. It appeared indeed that all rats were killed by $SO_2$, even when the concentration of 3 % had not been maintained. The fleas, however, jumped away from the rats, which had left their shelterplaces in an attempt to get away from the $SO_2$ and burrowed in the sand which covered the floors of the fumigated houses. In consequence of the process of fumigation they had been robbed of their hosts, and driven by hunger they attacked people, who, infected by these bites, incurred the possibility of getting plague.

Later on this method, the application of which also met with great difficulties, was abandoned, and replaced by the so-called preventive method, by which the houses were improved and in addition systematically cleaned; but yet GEORGE STICKER's saying holds good also with reference to this measure, when he says that plague is a „nole mi tangere" and that every attempt to combat it, when once it has broken out among people, but much too often leads to an increase in the number of cases among the people one has tried to protect.

At the time of its first dealings with the plague it had become quite clear to the local medical Board that plague among people could only be combatted with success if one could prevent it by systematic improvement of the houses (ratproof-building) of the native population. That one can be certain of preventing plague by providing suitably built houses is not only clear to any one, acquainted with the particulars of the plague epidemic, but is demonstrated best of all by the fact that in the case of Europeans and Javanese living in the same region, even in the same dessa as was, for instance, the case at Sempal Wadak, the Javanese who inhabit bad houses are infected by the disease in a terrible way, while the Europeans and the Chinese who live in good houses, remain free from infection.

On the advice of the Local Medical Board the ratproof building was therefore vigorously tackled and carried through by the Government. The whole district of Malang, nearly the whole residency of Madium, and a great part of Kediri were speedily improved. Soon the region became free from plague and has remained free from it up to the present. Up to the present 1.200.000 houses have been improved and many millions of florins spent there on.

Another disease, which drew the attention of the Local Medical Board, was the malaria.

In the communications of the I.C.O. committee l.c. the history of malaria research in the Dutch Indies was dealt with, while special mention was made of the great work done in these researches by men like SCHÜFFNER and DE VOGEL. Thanks to the work of SCHÜFFNER and SWELLENGREBEL it was possible to make a thorough study of the biology and systematics of the Indian Anophelinae.

So the basis was laid for a thorough study of the epidemiology of malaria in connection with the biology of the anophelines and it became possible to combat malaria in circumstances in which it appeared impossible to fight this disease, before the Board had made it its business to interfere.

Later on a special committee for the study and prevention of malaria was appointed. Professor Dr. RODENWALDT, chairman of the committee, did much valuable work. He made the biology of the Indian anophelines his particular study and made extensive researches throughout the whole of the Archipelago.

So one obtained knowledge of valuable details, especially with reference to the breeding places of the Myzomyia ludlowi, which is to such a large extent responsible for transmitting malaria, as far as the West of the region explored by RODENWALDT was concerned.

Thanks to a better knowledge of the breeding places of the M. ludlowi, and of the peculiar ways in which these breeding places are formed, RODENWALDT was able to combat malaria in a relatively simple and inexpensive manner.

The town of Sibolga may be mentioned in the first place as one of the examples where results were attained in the campaign against malaria, for after studying the biology of the mosquitos, which transmit malaria there, it was possible to sanitate a place, which had become uninhabitable owing to the prevalence of malaria.

Not less satisfactory were the results obtained with reference to the prevention of malaria at Tjilatjap and on the plateau of Tjihea, where RADEN MAS MARDJITO MANGKOEWINOTO discovered in the course of careful investigations that there the Myzomiya abbirostris was the cause of malaria. His researches showed that, after the reaping of the paddi, this mosquito, which normally breeds in the gently flowing rivulets and ditches with clear water, finds a welcome breeding-place in the numerous water reservoirs which form themselves on the rice fields.

By means of a rational distribution of the irrigation water, which just before the reaping of the paddi ought to be altogether withheld from the dangerous territory threatened with malaria it was possible to colonize with Sundanese the Tjihea plateau which was uninhabitable before MANGKOEWINOTO dealt with the matter.

Very important was the work done by SUNIER and VAN BREEMEN who irrefutably showed at Batavia, by marking mosquitos, that the Myzomiya ludlowi are able to cover distances from four to six kilometres to and from their breeding places. Several research workers, and in the first place VAN BREEMEN himself could prove that the spreading of malaria was closely connected with this flight.

Another sphere in which the Public Health Department could boast good results was that of the prevention of infectionus diseases by means of vaccination.

In 1804 vaccinating the population against small pox had been started, according to the so called "group system" ("Kringen systeem"). VON WASSKLIVICS divided Java and Madura in vaccination districts, a division which was very practical to facilitate vaccinating with human lymph, at that time *the* method in vogue. In the communications of the Public Health Department and also in a publication of Dr. C. F. C. WINCKEL this method of vaccination has been discribed.

Vaccination against small pox became very popular when Dr. NYLAND, Director of the Parc vaccinogène, then still situated at Weltevreden, succeeded in preparing excellent animal lymph, and in raising and in stabilizing the virulence of the cow pox lymph by means of various ingenious methods.

By making use of buffalo-calves and rabbits as intermediate animals it was possible to prepare great quantities of very active lymph, and by means of various devices it was possible not only in keeping this lymph a long time at Weltevreden, but also in sending it to remote places in such a way that it arrived in a virulent state. As early as 1898 NYLAND could state that in two residencies had been begun the experiment of supplying exclusively animal vaccine, and as early as 1907 he could state that he had been able to raise the production to such an extent that it was possible to introduce vaccination with animal lymph throughout the whole of Java and Madura. Now vaccination is not applied in any other way but with animal lymph throughout the Dutch Indies, even including the remotest districts.

In the Insitute PASTEUR and in the Parc vaccinogène, since 1923 transferred to Bandung, the physicians have not ceased to look for means by which it would be possible to render the durability of cow pox lymph greater still than it is at present. As a result of these efforts a publication of Dr. OTTEN, Director of the Institute PASTEUR, appeared in 1926 [1]); in this article he published the favourable results obtained by

[1]) Meded. Dienst Volksgezondheid 1926.

him with reference to experiments carried out with lymph dried, and consequently kept and despatched in perfect isolation of oxygen and air.

Thanks to the efforts of the physicians attached to and employed by the Parc vaccinogène and the institute PASTEUR it was possible for the Local Medical Board to take effective measures against small pox.

Soon the Public Health Department could record as excellent results as the military medical corps in the past with reference to the prevention of small pox among the military men. This was especially the case when an abundant supply of cow pox lymph made it possible to break with the so-called "group system", and to vaccinate according tot he method of TERBURGH, the so-called "combined system" as recorded in the communication of the I.C.O. Within a year East Java, where nearly 20.000 cases of small pox occurred per annum, was practically cleared from small pox.

The following statements give an idea of the increasing production of cow-pox lymph in the Institute PASTEUR during the course of years, and of the results obtained with reference to vaccinations which were systematically carried through.

| Years | Number of capillaries | Number of capillaries with tubes of glycerine to thin | | Number of vaccinations which could be done with the quantity of vaccine supplied |
|---|---|---|---|---|
| | | a. 1 c.c. | a. $^1/_2$ c.c. | |
| 1922 | 28.139 | 92.662 | 59.614 | 8.878.765 |
| 1923 | 21.434 | 116.994 | 66.069 | 10.860.040 |
| 1924 | 20.313 | 132.111 | 66.721 | 12.011.520 |
| 1925 | 25.768 | 113.286 | 59.961 | 10.424.120 |
| 1926 | 24.715 | 105.938 | 57.909 | 9.806.195 |

**Vaccinations.**

| Years | Number done | Number controlled | Number succeeded | Percentage succeeded |
|---|---|---|---|---|
| 1922 | 1.245.631 | 878.532 | 855.829 | 97.4 |
| 1923 | 1.358.396 | 980.947 | 957.215 | 96.5 |
| 1924 | 1.497.709 | 1.059.914 | 1.023.096 | 96.5 |
| 1925 | 1.486.884 | 979.569 | 950.751 | 97.— |
| 1926 | 1.347.321 | 980.468 | 939.907 | 95.8 |

Equally important results were obtained in the prevention of cholera by injecting the people who are to be protected with cholera vaccine prepared according to the method of KOLLE. In 1910 this inoculation was imported by NYLAND into the Dutch Indies. In te beginning it was rather difficult for this method to find acceptance, but the favourable results soon caused this vaccine to be made use of generally. In the different annual records of the Institute PASTEUR, and in some publications of the Public Health Department the method of preparing this vaccine has been described in detail, and so it will do to copy here a few statistics which demonstrate the effects of the cholera inoculation. This is the more important because after the war the leading epidemiologists strongly questioned the value of preventive inoculations against cholera and typhus abdom. Now it certainly cannot be denied that people properly inoculated against typhus abdom. and cholera still may suffer from typhus abdom. and cholera, although the latter rarely occurs, but it is just as certain that one would be immediately convinced of the importance of inoculations against cholera and typhus abdom., if one had an opportunity — not rare in the tropics — to compare groups of people who have been inoculated with other groups who, while living in the same circumstances, have *not* been inoculated.

So Dr. KREDIET, and later Dr. VAN ROMER succeeded in practically clearing Batavia of cholera by inoculating more than 60 to 80 % of the inhabitants with cholera vaccine.

**Chart showing the results obtained by Lianarous in inoculating against cholera.**

| Natives | Inoculated | | | *Not* inoculated | | |
|---|---|---|---|---|---|---|
| | Number | Morbidity | Mortality | Number | Morbidity | Mortality |
| Semarang .... | 8340 | 0.3 ‰ | 0.1 ‰ | 85000 | 6.5‰ | 5.5‰ |
| Singaradja ... | 4092 | 1. ‰ | 0. ‰ | 115000 | 9.9‰ | 7.6‰ |
| Denpassar .... | 1733 | 1.1 ‰ | 1.1 ‰ | 154000 | 2.9‰ | 2.7‰ |
| Selong ..... | 4875 | 0.2 ‰ | 0. ‰ | 154000 | 5.8‰ | 3.7‰ |
| Stagen (Pulu Laut) ..... | 1297 | 11.6 ‰ | 3.9 ‰ | — | — | — |
| | | | | 1071 | 11.2‰ | 5. ‰ |
| Europeans | | | | | | |
| Semarang .... | 2450 | 0. ‰ | 0. ‰ | 2676 | 14.2‰ | 5.2‰ |
| Purwakarta .. | 622 | 3.2 ‰ | 0. ‰ | 827 | 15.7‰ | 12. ‰ |
| Batavia ..... | 4000 | 0.25‰ | 0.25‰ | 4250 | 13.6‰ | 6.8‰ |

The number of casuistic cases, in which the success of inoculation against cholera was demonstrated, a casuistry which to a large extent has been recorded in the "Geneeskundig Tijdschrift voor Nederlandsch-Indië", is great, and any one who has witnessed in the Dutch Indies the campaign against cholera by means of wholesale inoculations cannot possibly doubt the benefit of inoculation.

In the case of inoculations against typhus abdom. one has only been able to record success when the community, which had to be protected, could be forced to have the inoculations repeated at regular periods. To inoculate against cholera it is sufficient to inject the people exposed to the infection with one single dose of cholera-vaccine but this is not possible in the campaign against typhus abdom. The people who require to be treated must be injected three times with intervals of at least five days, and one cannot get a free people to submit to this. The following information quoted from an article written by a doctor, who could wage a war against typhus abdom. in fortunate circumstances by means of inoculations, gives us the conviction that the inoculations against typhus abdom. can most certainly prevent the appearance of the disease, also when they happen to be the one and only preventive measure applied.

Dr. JENNISSEN, physician of the Billiton Company, had an opportunity to observe a typhus epidemic, and was compelled by force of circumstances to carry out an experiment which shows better than lengthy statistics do, the use of typhus inoculations as a prophylactic measure. A pool, in which the Chinese workmen, whom Dr. JENISSEN had under observation, defecated and bathed, was found to be the source of infection. In the water of this pool typhus bacilli were indicated, and also the epidemilogical course of the typhus pointed to the pool as source of infection. A number of the labourers could be inoculated with typhus-vaccine, in the case of the others this was for various reasons impossible, f.e. because they refused to undergo the inoculation. Dr. JENISSEN relates the following with reference to his experiences:

"During the time from the 7th of September until the 3rd of October, while the disease was still very prevalent, inoculated and not inoculated labourers worked side by side and mixed together in absolute equal circumstances, from 7—20 September 110 inoculated men against 659 not inoculated ones, and from Sept. 20th until Oct. 3rd 391 inoculated men against 424 not inoculated ones. The number of typhus cases, which occurred during that time, amounted to 97, but we (JENISSEN) state the fact that not a single case of typhus occured among the inoculated labourers in as far as they were not inoculated during the incubation of the disease."

Another sphere in which the Public Healt Department could record results is in the campaign against framboesia tropica in Java and in the other islands.

It had been known a long time that Salversaan was a specific against framboesia. As early as 1911, for instance, the Dutch had shown in Surinam the benefit of injections with Salversaan in cases of Framboesia tropica.

They had at that time succeeded in rendering superfluous a whole isolation hospital for framboesia patients by curing the patients in this institution with Salversaan injections.

In the Netherlands Indies the campaign against framboesia was organized in about 1919.

Dr. Ch. W. F. Winckel published in the communications of the Public Health Department the results obtained in this campaign, and the organization necessary to the waging of this war. The systematic cure of framboesia began in the second half of the year 1919. Since that time far more than 300 K.G. neosalversaan has been supplied by the Public Health Department, for which the population, which can be injected with neosalversaan for a small consideration, paid *f* 340.000.

As far as is known the following numbers of patients were injected.

| | |
|---|---|
| 1919 ..... | a couple of thousands. |
| 1920 ..... | 60.000 |
| 1921 ..... | 300.000 |
| 1922 ..... | 350.000 |
| 1923 ..... | 180.000 |
| Total ..... | 890.000 |

Since 1923 thousands have still been treated so that the number of treated people is far over a million.

What a systematic treatment of framboesia means for the population can only be sufficiently appreciated by him, who has seen what dreadful consequences framboesia can bring on for the inhabitants of an area, where it prevails endemically.

A scientific institution, which is of great importance in the Dutch Indies for the advance of tropical medical science, is surely the medical Laboratory at Weltevreden. Immediately after the foundation in 1887 this laboratory was established in a part of a ward of the large

military hospital at Weltevreden. When later on a course of lectures was given to tropical physicians, and also a library had to be instituted, some temporary rooms were built for that purpose in the garden behind the ward. Increasing demands soon caused these premises to be too small, and as early as 1912 Dr. GRIJNS had to propose the building of an altogether new and up-to-date laboratory. This laboratory was built on the grounds of the Stovia and the hospital complex on the Salemba road to Meester CORNELIS, and put to use in 1916. In 1920—1922 it was considerably enlarged, so that it is a monumental building now with a great number of excellently appointed work-rooms for bacteriologic, serologic, pharmaceutic and chemical research, and work rooms for instrument makers, while it also contains an excellent library.

The Staff consists of a Director, a sub-director for the chemical division, about 5 physicians for the medical-bacteriologic division, 4 assistants for the chemical division and moreover 6 analysts, 2 administrators, 2 amanuenses, and 27 servants.

Among the important researches carried out in the medical laboratory those of EYKMAN dating from 1887 until 1893 must be mentioned in the first place. EYKMAN made in the old medical laboratory his researches into the physiology of the inhabitants of the tropics. With the results which he obtained and which showed that the inhabitant of the tropics possesses the same blood structure as the inhabitant of the more temperate zones he drove away the bogy of tropical anaemia. By showing that also the metabolism of the inhabitant of the tropics differs in nothing from that of the inhabitant of the temperate zones he placed the study of tropical diseases and of tropical hygiene on a firm footing; in his text-book on tropical hygiene CLAUS SCHILLING very rightly calls him the founder of tropical hygiene.

EYKMAN'S studies on the causes of Beri Beri are doubtless even more important. In a series of researches prolonged during three years he succeeded in showing that Beri Beri is caused by a one-sided dietary. Together with VORDERMAN he could point out that Beri Beri occurred much in all prisons where white polished rice was supplied, while in the prisons where the prisoners were fed with rice to which the silver cuticles were still attached little or practically no Beri Beri occurred.

The following figures clearly show this:

| | | Beri Beri |
|---|---|---|
| Prisoners fed with silver-cuticle-rice ..... | 96.530 | 1/10 ‰ |
| Prisoners fed with polished rice (devoid of silver cuticle) | 150.260 | 29.9 ‰ |

After EYKMAN's departure from Weltevreden in 1895 important work was done by Dr. GRIJNS who was also attached to the laboratory; he proved that Beri Beri was caused by a deficiency in the food. He first demonstrated that in all articles of food, in the one kind more than in the other, a peculiar substance occurs, which is indispensable to the ordinary physiologic function of the nerves. If this substance was taken out of the food, which happened when the rice was separated from its silver cuticle, then the person who had been fed a long time without a change on that rice would show symptoms of Beri Beri. As Dr. GRIJNS remarks one does not get Beri Beri so much on account of what one eats as on account of what one does not eat.

The results of these investigations have been of incalculably great importance. In the first place it was possible not only to cure, but also to prevent Beri Beri, by improving the food: e. g. by supplying unpolished rice, whereever rice devoid of the cuticles had been supplied before.

Further it became evident in the course of time that a number of diseases, such as sailing vessel Beri Beri, scurvy, hemeralopie, rickets, etc. are connected with a wrong dietary. Again and again it has been proved that these diseases can not only be cured, but also be prevented by improving the food. For these substances which must be found in every kind of food if it is to keep us in normal health, CASIMIR FUNK introduced the name of vitamins.

Before the investigations of HOLTZ on scurvy the results of EYKMAN's research work had not been looked upon in Europe with the attention they fully deserved. Afterwards physicians began to see the great importance of his investigations, not only for the prevention of Beri Beri, but also with reference to several diseases which occur in Europe, and the great significance of vitamins became quite clear.

Where one has recently heard a few voices out of the tropics — and then always from regions where the staple food of the population does not consist of rice — who doubt the connection between lack of vitamins and Beri Beri, it may be useful to reproduce the following tables which give an impression of the importance of a well-regulated dietary for the prevention and cure of Beri Beri.

Survey of cases and rate of mortality of Beri Beri on estates of the Senembah Company (after SCHÜFFNER).

| Years | Number of labourers | Number of patients | | Mortality rate | |
|---|---|---|---|---|---|
| | | Total | On 10.000 healthy people | Total | On 10.000 healthy people |
| 1897 | 3824 | c.a. 270 | 707 | 90 | 235 |
| 1898 | 4029 | 98 | 243 | 24 | 60 |
| 1899 | 4330 | 7 | 16 | 6 | 14 |
| 1900 | 4167 | 12 | 28 | 2 | 5 |
| 1901 | 4590 | 11 | 24 | — | — |
| 1902 | 5132 | 10 | 19 | 2 | 4 |
| 1903 | 5909 | 4 | 7 | 1 | 2 |
| 1904 | 5656 | 3 | 5 | — | — |
| 1905 | 5684 | 7 | 12 | — | — |
| 1906 | 5666 | 4 | 7 | — | — |
| 1907 | 6603 | 12 | 19 | — | — |
| 1908 | 6798 | 22 | 32 | 2 | 3 |
| 1909 | 6982 | 40 | 57 | 1 | 1 |
| 1910 | 6730 | 25 | 31 | — | — |

SCHÜFFNER, from whose article on "Die gesundheitlichen Verhältnisse der Arbeiter der Senembah Maatschappij" in the "Archiv für Schiffs- und Tropenhygiene" (Band 16, 1912. 277—304), the above list has been quoted, remarks in connection with the figures that he began his work with the „Senembah Maatschappij" in a time when a kind of epidemic of Beri Beri was just beginning to disappear. After a rapid decrease during 1898 and 1900 the disease altogether receded into the background as early as 1901. The morbidity as well as the mortality of Beri Beri remained practically the same on his estates up to 1908, when the number of cases increased again. He took the dietary measures discussed before, and had rice supplied with a sufficient percentage of silver-cuticle with the success that the Beri Beri soon disappeared.

The research work concerning vitamins was after 1914 continued by JANSEN. In a number of publications, which all appeared in the Communications of the Public Health Department, the results of his investigations were recorded. In 1926 they culminated in the fact that JANSEN and his fellow-worker DONATH succeeded in separating the substance which prevents Beri Beri, as a chemically pure substance out of the silver cuticle of the rice. This substance bears the formula $C_6\ H_{10}\ O\ N_2$ and crystallizes. Small quantities, fractions of a milligramme,

added to the food of trial-animals, are able to protect these with absolute certainty from getting Beri Beri.

It is indeed a fortunate coincidence, that in the same institute, where EYKMAN made his important discovery of the cause of Beri Beri also the substance, the deficiency of which in the food is the cause of Beri Beri, was chemically and purely isolated in 1926.

The work in the medical laboratory was however not limited to what has been already discussed. Several subjects bearing upon tropical physiology, upon general bacteriology, upon epidemiology, hygiene and parasitology were studied, and often it was possible to solve obscure epidemiologic problems, and to point out new ways.

Especially with reference to the epidemiology of plague, typhus abdom., cholera and dysentery important research was carried out by the medical laboratory.

Also hygienic problems were solved there. In this connection special mention must be made of the work of GRIJNS and EYKEN with reference to the purification of the soil at Weltevreden, when the possibility was suggested of filtering into the soil the septic liquid out of septic tanks.

In 1920 it was proposed by the Director of the Laboratory, in collaboration with the chief of the division Sanitation of the Engineering Department to institute a division where specially appointed officials would be able to take upon them the study of problems bearing upon the water supply and the purifications of refuse water. In 1923 this division was called into existence on the land of Mangarai. Several valuable publications have already been published by that sub-division of the laboratory, and advise has been given by it with reference to the water supply, the purification of drinking water, the purification of refuse water and the disposal of faeces.

At Weltevreden there are several hospitals, private ones, as well as hospitals exploited by the State. The large military hospital situated at the Garnizoensweg at Weltevreden has already been mentioned. In the main buildings of this hospital is the library which has been discussed on page 209.

Special mention must be made of the Central Civil Hospital, because this institution is also used by the medical University at Weltevreden in connection with its clinical teaching. Together with the buildings of the University and with those of the Medical Laboratory they form the „Salemba complex", a centre where much scientific work is being done. Out of the hospital as well as out of the Stovia, now changed into a University, several valuable publications appeared with reference to physiologic-chemistry, pathologic anatomy, and clinical work.

Bandung, the beautiful capital of the "Preanger Regentschappen", is the seat of the technical University and of the professor of hygiene at this University.

There also the "Institut Pasteur" is situated, which was transferred from Weltevreden to Bandung finding there worthy accommodation in the roomy buildings at the "Dagoweg". This building-complex and its organization was fully discussed in the Communications of the Public Health Department 1924. The work done in the "Institut Pasteur" and in the Parc Vaccinogène has been of great importance to public health in the Dutch Indies.

It has already been mentioned how NYLAND succeeded in speeding up the production of cowpox vaccine, how methods were found to get the cow-pox vaccine to keep its virulence and how later OTTEN succeeded in keeping the virulence of the lymph high during a long time, also in the high temperature prevalent in the tropics, by keeping the dried cow pox lymph in exhausted and air-tight fused tubes.

In the Institute Pasteur inoculations against hydrophobia are also applied. Thanks to the preventive inoculation thousands are kept from terrible suffering and from a certain death. The preparation of the therapeutic and diagnostic sera is also entrusted to the Institute Pasteur, while the different vaccines are prepared there too.

The figures below give an idea of the activity at the Institute and of its importance.

**Vaccines supplied during 1926.**

| | | |
|---|---|---|
| Cholera vaccine | 112.237 | c.M.$^3$ |
| Mixed cholera-typhus vaccine | 334.342 | ,, |
| Mixed Typhus, paratyphoid A and B vaccine | 282.348 | ,, |
| Meningococcen vaccine | 12.290 | ,, |
| Polyvalent Staphylococcen vaccine | 4.825 | ,, |
| Gonococcen vaccine | 30.089 | ,, |
| Strepto coccen vaccine | 1.249 | ,, |
| Whooping-cough vaccine | 1.789 | ,, |
| Alt tuberculine | 1.465 | ,, |
| Bouillon filtre Denys | 226.— | ,, |
| Therapeutic sera | | |
| Tetanus serum | 108.005 | Liters |
| Dysentery serum | 273.11 | ,, |
| Meningococcen serum | 9.37 | ,, |
| Snake's poison serum | 13.48 | ,, |
| Diptheria serum | 23.53 | ,, |

Much study and research was needed to obtain these results, for with a view to the special circumstances prevailing in the tropics, special methods had to be worked out and applied, and methods, which gave good results in Europe not infrequently had to be modified to suit the special demands of the tropical climate.

The results obtained by research workers in Deli have been of great importance for the practical hygiene on agricultural estates and industrial undertakings.

It was SCHÜFFNER in the first place who did a great deal in the campaign against coolie diseases, and more important work still in the prophylaxis of these diseases placing it on a scientific basis in the laboratories and hospitals of the Senembah Company.

He introduced a system of treatment of the diseases, and of organization and concentration of hospital nursing, which enabled the medical attendants to allow themselves much time for the study of purely hygienic problems for the prevention of the most important coolie diseases. Thus it was possible to work out methods, by which one was able to pull down the rate of mortality and the sick-rate among a population of agricultural labourers at the sacrifice of minimal sums of money.

Soon SCHÜFFNER could show excellent results. Together with KUENEN, who came to Deli in 1903, (SCHÜFFNER had been there ever since 1897) the work was extended over other company-complexes, e. g. over those of the Deli Company.

Soon the need of centralizing was realized, not only in the matter of hygiene, but more in particular in bacteriologic and parasitologic research, so necessary to the application of hygienic measures, and thus the laboratory for Pathology was established in 1906.

The work done at the laboratories at Tandjong Morawa, as well as at the laboratory for Pathology at Medan, has been of marked importance for the development of the estates on Sumatra's East coast. It was not until better rates of mortality could be shown in Deli, than had been the case up to 1897, that the Dutch Government succeeded in engaging coolies in greater numbers in Java. Moreover it was only when the managers had the disposal of healthy coolies that it was possible for them to exploit their plantations without too great a loss of labour and human lives. But also for the scientific research of diseases prevalent in the tropics the work in both laboratories has been of great importance. As pioneers the workers at these laboratories have prepared the way for others, and so we soon see at other plantations, e. g. at Petumbukan etc., the appearance of centra after the example of Tandjong Morawa. The workers at all these laboratories have done very much towards the

development of the scientific study of diseases prevalent in the tropics.

In consequence of the better knowledge obtained by these researches it was possible to prevent these diseases and their spreading.

In this connection one may mention the researches of KUENEN into the pathologic anatomy of the amoebic dysentery, and the researches of KUENEN and SWELLENGREBEL into the cycle of development of the pathogenic amoeba, the Entamoeba tetragena. They showed that the pathogenic amoeba is able to leave the diseased tissues in certain circumstances, and to lead a saprophytic existence, as a so-called minuta form, in the intestinal contents. It is of specially great importance that their researches showed the connection between the different forms, as for instance are found in the faeces, and the clinical symptoms diagnosed in the patient.

On the strength of this information the clinical workers subjected the motions of their patients to a systematic examination, by which they learned much about the aetiology of some intestinal diseases, which regularly occurred among their patients in many places in the Dutch Indies, especially in the large towns, and which usually ran their course under all sorts of indefinite and vague complaints about the abdomen.

The fact that at that same time muriatic emetine was found by LEONARD ROGERS to ensure a more successful treatment of amoebic dysentery than had been possible thus far caused the researches of SWELLENGREBEL and KUENEN to be of such great and immediate use to the treatment of amoebic dysentery.

Long before that time SCHÜFFNER had taught us to prevent the amoebic dysentery among an agricultural population by supplying the coolies with large quantities of tea. By drinking the tea the necessity for the coolies to drink inferior water while working on the fields was eliminated.

Of great importance has been the research of Dr. KUENEN into the dysentery caused by bacilli. In numerous articles he told us about his work with reference to the prevention of the importation of cholera and typhus abdom.in Deli.

By very accurate observations and exact measures the physicians in Deli produced a great deal of evidence, which confirmed still more the theory of the connection between rice feeding and Beri Beri, formerly so strongly born out by EYKMAN.

The organized campaign against hook worm has been of not less importance. By systematically applied cures against hook worm, and by accurate observation of the patients and of the healthy labourers, they managed to reduce the severity of the infection with ankylostoma,

so that the infected persons would show no clinical symptoms, notably no anaemia as a consequence of that infection.

Later on, the methods for the investigation into the epidemiology of hook worm disease were even more ingenious. In this connection the investigation of BAERMAN into the spreading of hook worm larvae in the environment of labourers houses may be mentioned. He worked out an ingenious method for the examination of the soil, by which it is possible to get information of the extent to which the hook worm larvae have spread in the soil, a method which the Americans, members of the ROCKEFELLER's prevention of ankylostomiasis, are keen to apply.

Better than a long discription, the following list will give an impression of the success by which the work of the research workers in Deli has been crowned.

Besides all this the research of SCHÜFFNER into the so-called pseudotyphoid in Deli remains to be mentioned. These researches brought SCHÜFFNER to discover that this pseudotyphoid is a form of the Tsutsugamushi, the Japanese flood-fevers, and that it is caused by the sting of particular Acarina species.

VERVOORT's work with reference to fevers of unknown aetiology in Deli put him on the way to discover a spirochaet to be the cause of a group of these fevers, the Spirochaeta pyrogenes. These were cultivated by VERVOORT and accurately examined.

A number of research workers, BAERMANN, KOUWENAAR, VAN DE VELDE and others now began to look for spirochaetae in the case of feverish diseases. These were consequently found with some of these diseases, and so it became an undisputed fact that beside malaria and typhoid also spirochaetae can be the cause of feverish diseases in Deli.

In the course of such investigations it appeared that WEILL's disease was not unknown either in the tropics, and often occurred there in epidemic form.

It must be clear that, thanks to these researches, our knowledge and power to prevent suchlike diseases has been considerably enlarged.

**Rates of mortality of the coolies employed by the Senembah Company.**

(according to SCHÜFFNER and KUENEN).

| Year | Number of labourers | | | | Total rates of mortality | | | | In ‰ of the number of labourers | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chin. | Jav. | Women | Together | Chin. | Jav. | Women | Together | Chin. | Jav. | Women | Together |
| 1897 | 2279 | 1879 | 718 | 3824 | 186 | 37 | 9 | 232 | 86.2 | 42.2 | 13.5 | 60.2 |
| 1898 | 2386 | 1054 | 589 | 4029 | 152 | 25 | 16 | 195 | 63.7 | 23.7 | 27.2 | 47.8 |
| 1899 | 2517 | 1306 | 507 | 4330 | 98 | 32 | 19 | 149 | 38.9 | 24.5 | 37.5 | 34.4 |
| 1900 | 2633 | 1033 | 501 | 4167 | 140 | 31 | 17 | 188 | 53.2 | 30.0 | 33.9 | 45.1 |
| 1901 | 2757 | 1225 | 608 | 4590 | 137 | 39 | 51 | 227 | 49.6 | 31.8 | 83.8 | 51.6 |
| 1902 | 2760 | 1476 | 896 | 5132 | 124 | 30 | 24 | 178 | 52.9 | 20.3 | 25.7 | 34.5 |
| 1903 | 3212 | 1722 | 975 | 5909 | 170 | 29 | 27 | 226 | 47.9 | 16.8 | 27.7 | 38.2 |
| 1904 | 3283 | 1497 | 896 | 5656 | 74 | 25 | 14 | 113 | 52.9 | 16.7 | 15.6 | 19.9 |
| 1905 | 3032 | 1795 | 857 | 5684 | 41 | 11 | 11 | 63 | 22.5 | 6.1 | 12.9 | 11.1 |
| 1906 | 2944 | 1668 | 1054 | 5666 | 40 | 14 | 7 | 61 | 13.2 | 8.4 | 6.6 | 10.8 |
| 1907 | 3273 | 2036 | 1194 | 6503 | 64 | 14 | 19 | 97 | 19.5 | 6.9 | 15.9 | 14.9 |
| 1908 | 3234 | 2251 | 1313 | 6798 | 34 | 20 | 10 | 64 | 10.5 | 8.9 | 7.5 | 9.1 |
| Together | 34310 | 17945 | 10057 | 62308 | 1260 | 307 | 224 | 1791 | | | | |

It is clear that systematic researches ensuring good scientific results can be best carried out in well fitted and well-equipped laboratories, but it would be ungrateful not to pay special homage to those solitary workers who have devoted themselves with very good results to excellent scientific work far from every scientific centre.

A glance at the table of contents of the "Geneeskundig Tijdschrift voor Nederlandsch-Indië", and at the Communications of the Public Health Department is sufficient to convince us how much the research into tropical diseases owes to these solitary workers.

It is only due to a necessary limitation in compiling this short outline that here their work has not been considered in more detail with the interest it certainly deserves.

# THE DEVELOPMENT AND THE PRESENT-DAY STAND-POINT OF SCIENTIFIC VETERINARY RESEARCH IN THE NETHERLANDS INDIES

by Dr. L. DE BLIECK,

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From 1838 onwards the Netherlanders have been engaged in research work with reference to animal diseases in the Dutch East Indies, but not until many years later the necessity also to supply veterinary instruction in the Indies was realized. While in the Netherlands the development of Scientific Veterinary research has been keeping pace with the improvement of the instruction, as the then Veterinary College at Utrecht used to be the only place where researches were made, research in the Netherlands Indies reached a high standard before veterinary teaching was promoted as well. In 1821 the Veterinary College at Utrecht was founded; on account of the great need of veterinary surgeons in the mother country no qualified veterinary surgeons went to the Indies at first. From 1838—1852 there were exclusively military veterinary surgeons in the Indies, but there were only a few: in 1856 there were four. Until 1852 the civil veterinary service was entrusted to the military veterinary surgeons, after 1852 to so-called Government veterinary surgeons; the first of these was TH. RIJKSEN.

Up to 1885 little had been done in the sphere of scientific veterinary research; the veterinary surgeons got to know the most prevalent diseases, particularly the epizooties (cattle-plague, anthrax, foot- and mouth disease, glanders). Especially cattle-plague made great demands on the attention and energy of the veterinary surgeons, as this disease caused a great mortality in the Indies, and it was to combat this plague in particular that veterinary surgeons had been sent out.

From 1884 onwards veterinary science receives more attention. An Association of veterinary surgeons, called the Association for the Advancement of Veterinary Science in the Netherlands Indies (Vereeniging tot bevordering van Veeartsenijkunde in Nederlandsch Indië), was founded and in 1885 it published a periodical by the name of "*De Veeartsenijkundige Bladen van Ned. Indië*", which still regularly

appears, and which contains most literature concerning scientific veterinary researches. Since 1918 the name of this periodical has been "*Nederlandsch Indische Bladen voor Diergeneeskunde en Dierenteelt*" (Netherlands' Indian publications in behalf of veterinary science and the breeding of animals.)

Also in the "*Tijdschrift van Geneeskunde van Nederlandsch Indië*" (Periodical of the medical sciences in the Netherlands Indies) a number of veterinary researches are found. That even in 1886 veterinary research had not yet reached a high standard is borne out by the Colonial Report of that year in which mention is made of cattle-plague, anthrax, glanders, foot- and mouth disease, and of the *occurrence of a number of unknown diseases*. The Association of veterinary surgeons says in its report of 1887: "Veterinary science has a future in the Netherlands Indies." Yet very interesting articles are to be found in the first periodicals. So J. DE JONGH writes about "sarcosporidia in buffaloes" in 1886; then I refer to a communication in 1887 by C. A. PENNING, who later produced a great deal of very good work with regard to the occurrence of cattle-plague among pigs, experimental researches, which, however, became but very little known. In the Indies PENNING's researches were later on corroborated by DE DOES and others. H. MARS made experiments with iodine on skin diseases caused by microphytes. The military veterinarian PLEMPER VAN BALEN wrote about eye-diseases in horses. In 1887 A. VRIJBURG did investigations into cattle-plague in Deli, and later he made many other very important researches. DRIESSEN and MARS wrote about the feeding of the animals and dietatics in the Indies.

In proportion as the number of veterinary surgeons increases research-work is being done on a larger scale too, while microscopy and bacteriology was also applied to the veterinary sciences. A laboratory for research work, however, was not instituted until 1908, but the veterinary surgeons usually had the opportunity to carry out their experiments either in hospitals or in special medical laboratories. Particular mention must be made here of the Laboratory for pathological anatomy and bacteriology, later known by the name of Medical Laboratory at Weltevreden, and the Medical Laboratory of the Deli Company at Medan, where a number of valuable researches were made. Among those who worked at the Medical Laboratory at Weltevreden are the military veterinary surgeons HOOGKAMER and VAN DEN BURG.

One of the most important and far-reaching researches into animal diseases is the one concerning the "polyneuritis in fowls" by Dr. G. EYKMAN in 1889—1891, which led to the discovery by him of the cause of beri-beri, and a rational method of combating it. Besides by EYKMAN Polyneuritis (avitaminosis) among fowls was studied and elaborated

by Dr. G. GRIJNS (1907—1908), who proved that polyneuritis was a deficiency disease. DE HAAN and GRIJNS showed in 1908 that in the case of polyneuritis antigen and so-called antibodies are wanting.

Up till 1890 little has been done in the Indies with regard to animals in the sphere of bacteriological and protozoölogical research. The first researches in that direction were made by J. W. F. J. VAN EECKE, a member of the staff at the medical Laboratory; in 1891 he established the cause of the "septicaemia of the buffalo", and in 1894 he discerned the pectoral form of septicaemia haemorrhagica. His researches into strangles and sarcosporidia are also of importance.

The military veterinary surgeon L. J. HOOGKAMER made in collaboration with Dr. J. DE HAAN researches into malleïn-test which led to a more accurate estimation of the reactions after malleïn-injections.

Also the Director H. F. ROLL realized the great importance of research into animal diseases, and so he added a veterinary surgeon to the Staff of the Laboratory.

In consequence of the detachement of the Government veterinary surgeon J. F. K. DE DOES the co-operation between the medical Laboratory and the practice of the veterinary surgeons was promoted. DE DOES deserves to be mentioned here with respect and gratitude; he worked at this laboratory from 1898—1907 and made a series of valuable discoveries. Standard researches were made by him; I only recall to memory his informations on the Trichophyty and Microspory of the horse, the Lymphangitis Epizootica of the horse and of one-hooted animals, Dourine, Surra, Piroplasmosis, Osteomyelitis of the buffaloes, Filariasis of the horse and of cattle. DE DOES's researches are characterized by their great accuracy, especially with regard to pathological-anatomical and histological descriptions, but also the aetiology of animal diseases in the Netherlands Indies has been advanced by him.

Unfortunately DE DOES had to take a prolonged rest in 1907 on account of ill health, and after his return to the Indies he has no longer been able to devote himself much to research work.

The research-work done at the Medical Laboratory was moreover a stimulus for the practising veterinary surgeons to apply themselves to a greater extent to scientific work, which was borne out by contributions in the veterinary periodicals from DRIESSEN, PENNING, FISCHER, ESSER, VAN VELZEN, B. VRIJBURG, SOHNS, HELLEMANS, DE VLETTER, VAN LIER and others.

I already mentioned the Pathological Laboratory at Medan, where the veterinary surgeon of the Deli Company, Dr. A. VRIJBURG regularly devoted himself to research-work. Of particular interest are his inves-

tigations on Surra, Piroplasmosis, Cattle-plague and "Farcin du boeuf", the cause of which was discovered by him.

The veterinary surgeon C. S. JERONIMUS investigated at Medan the effect produced by arsenic and arsenic-preparations on surra and piroplasmosis in the case of the larger domestic animals; the results of this study were published in the G. T. v. N. I. part. XLIX.

With the foundation of a laboratory of its own, viz: the Laboratory for Veterinary Sciences at Buitenzorg, veterinary research entered upon a new phase of its existence. DE DOES had repeatedly pointed out the necessity of establishing a veterinary laboratory. After having been appointed Director of the Department of Agriculture, of which the Civil Veterinary Service forms a sub-division, it was Professor MELCHIOR TREUB, who finally took the initiative of founding a veterinary laboratory; he organized this laboratory in the same way as all the other scientific laboratories of the Department, that is to say, it was made to form an independent branch of the Department, and it has remained to be so up to the present-day. I wish to make a special point of saying here that this is, to my mind, the only right way of looking at it, for, although this laboratory always had to be at the service of the practical work with regard to the cure and prevention of diseases, which is the task entrusted to the veterinary service, yet it is able, on account of its independant status, always to devote its undivided attention to research work as well.

The laboratory as a centre for research was founded in 1908, and at the same time it was utilized also in connection with the training of native veterinary surgeons. Soon it became evident that more staff and more buildings were required for this training, and so the number of the staff was gradually increased between 1908—1915, while also a complex of buildings were erected. The first Director was Dr. L. DE BLIECK; he was appointed in 1908, and in 1909 he also accepted the headship of the Native Veterinary College. Up to 1919 both institutions remained under one head; after that each of them grew to such proportions that they had to be separated. Dr. H. J. SMIT, who had been a lecturer at the College since 1909, became its president, which he has been up to the present-day. In 1915 Dr. DE BLIECK went home, and was succeeded by J. C. TH. SOHNS until 1920. From 1921 up to the present day Dr. C. BUBBERMAN has been the director of the Veterinary Laboratory, which has grown tremendously under his management, not only with regard to the research department, but also with reference to its activities in the matter of the preparation of sera and vaccines for the cure and prevention of animal diseases.

In 1927 the name of the establishment was changed into "Veeartsenijkundig Instituut" (Veterinary Institution).

As the activities of the Veterinary Service increased and greater demands were made on it in all directions, more experts were wanted on the staff, and so the need of veterinary teaching made itself felt more and more too. The school had to be enlarged in consequence, and an absolutely new College was built at Buitenzorg in 1928.

Like the Veterinary Laboratory, the Netherlands-Indian Veterinary College has also, since 1908, published a series of informations with regard to veterinary research. These have for the greater part been coming out in the veterinary publications of the Netherlands Indies under the title of "Veeartsenijkundige mededeelingen van het Departement van Landbouw" (Veterinary publications by the Board of Agriculture). They will be briefly indicated by their number.

In order to give a fairly accurate idea of these two establishments and their functions, a short description be added of the Veterinary Institution and the Veterinary College.

The task of the Veterinary Institution is:

1. Research into the nature and character of prevalent animal diseases, especially with a view to finding a possible and practical way of combating them.
2. The preparation of sera, vaccines, and diagnostics which may serve towards the cure and prevention of the diseases.

In 1908 a beginning was made with the research work mentioned under 1. Soon after, in 1909, the following products were prepared: mallein, tuberculin, sera and vaccines against septicaemia haemorrhagica and anthrax.

Notwithstanding the difficulty to cause prophylactic inoculation to find acceptance with the native population, it has become evident in the course of years that there is a great need of it, and in consequence this department of the Institution has been particularly developed. Undoubtedly the methods of combating diseases by means of immunization as evolved by the Veterinary Service have won the native's confidence. Dr. BUBBERMAN stated in a lecture, held at the "Koloniaal Instituut" (Colonial Institution) at Amsterdam on January 17th 1928, that as much as 1300 L. sera for immunization had been supplied in 1927. By immunization against anthrax, this disease in horses has practically disappeared in Roti. The institution now prepares serum and vaccine against septicaemia haemorrhagica of the buffalo, fowl cholera, blackleg, cattle-abortion, fowl diphtheria. Altogether there are 70 serum-producing animals present.

Special importance may be attached to the fact that in the Indies the modern immunization against blackleg, e.g. by means of so-called germ-free filtrates, was with success applied by BUBBERMAN, before the old methods had been abandoned in the Netherlands. The results of this immunization are splendid.

The Institution consists of five departments, each under the management of a European expert, to wit:

1. The department for research in connection with material, send from the practise.
2. The department for the preparation and control of sera and vaccines.
3. The department for glanders, tuberculosis and serological research.
4. The department for poultry diseases.
5. The zoological department.

The management of the first four is entrusted to veterinary surgeons-bacteriologists, while a zoologist is at the head of the fifth department. These European departmental managers are assisted by three qualified natives who have finished their studies at the Veterinary College at Buitenzorg. Besides the so-called routine diagnostic work which is chiefly carried out by the native veterinary surgeons, research-work is done as much as possible in each department, and continued in practice, if necessary.

In the discussions on the different animal diseases the results of these researches are brought forward.

The department for poultry-diseases is of very recent date; in a short time much has been found out with reference to prevalent poultry diseases in the Netherlands Indies.

The zoological department was formed with a view to having the zoological problems, which particularly present themselves in connection with parasitical blood diseases, studied by a zoologist-parasitologist. This department has accordingly been engaged in the study of the question of trypanosomes, and in particular with the zoological side of it — viz: the transmission of the Surra in the Netherlands Indies. In 1925 Dr. J. H. SCHUURMANS STEKHOVEN published the results of his studies with regard to the tabanides which are found in the Indies, while Dr. O. CH. NIESCHULZ has been devoting himself during these last three years to the study of the biology of the tabanides, particularly with reference to their capacity of transmitting the surratrypanosomes.

The Netherlands Indian Veterinary College, which was started in a small way in 1908, has now become a big institution. In his address, delivered at the opening of the new college on June 30th 1928, Dr. H. J. SMIT gave a good historical survey of Veterinary instruction in the

Netherlands Indies. From as early as 1860 onwards instruction in this subject has been supplied to the natives, but it was not until 1908 that one could at all speak of a complete training. In the first years the instruction was given by two permanent lecturers, and by the veterinary surgeons of the Veterinary Laboratory. The propaedeutic subjects were followed at the Agricultural College; in 1926 the N. I. V. S. (Netherlands Indian Veterinary College) instituted its own propaedeusis.

The present staff consists of a teaching director, five veterinary lecturers, each aided by an assistant-lecturer (Indian veterinary surgeon) and one non-veterinary lecturer. At the opening of the college in 1908 there were 2 pupils, at present (1928) there are 50 pupils. The College has turned out 99 qualified native veterinary surgeons. With its present organization of the teaching staff, its excellently appointed buildings and laboratories this college has become a valuable centre for veterinary research. The teaching is still being conducted on the lines of the secondary school; some time ago there was talk of raising it to the level of university education. And it seems to me that the time for the realization of these plans cannot be far. A combination with the medical faculty would be the best solution.

And now let us proceed to consider which results have been obtained with regard to the most prominent diseases by the scientific study of these diseases in our Archipelago; only the chief sources of literature will be mentioned.

Apart from the articles in the „*Geneeskundig Tijdschrift voor Ned. Indië*" (G. T. v. N. I.), and "*de Veeartsenijkundige Bladen voor Ned. Indië*" (V. B. v. N. I.), eventually "*Ned. Ind. Bladen voor Diergeneeskunde en Dierenteelt*" (N. I. B. v. Dg. en Dt.) annual reports of the Civil Veterinary Service, of the Veterinary Institution, and of the Netherlands Indian Veterinary College are to be found in the "*Jaarboeken van het Departement van Landbouw*".

The publications by the Civil Veterinary Service refer to the practical work with regard to the cure and prevention of diseases, and to the measures taken towards the improvement of raising of live stock.

Great attention has always been given by the Government Veterinary surgeons to this last-mentioned branch of service; besides devoting their energies towards the cure and prevention of animal diseases they also act in the capacity of stock-raising consulting experts. Apart from a great number of articles on zoo-technic in the veterinary publications, a number of theses have been edited during these last years: viz: by Raden Soeratmo: "Een studie van de rundveeteelt in de Residentie Kedoe en omliggende Regentschappen, 1923" = (A study

on cattle-breeding in the Residency Kedu and environing Regencies, 1923).

J. KOK: „Het rund en de rundveeteelt op Madoera, 1921" = (Cattle and cattle-breeding in Madura, 1921.)

J. MERKENS: „Bijdrage tot de kennis van de karbouw en de karbouwenteelt in N. O. Indië, 1927" = (Contribution towards studies on the buffalo and buffalo-breeding in the Netherlands Indies, 1927).

## CATTLE-PLAGUE.

Cattle-plague did so much harm in our colony that as early as 1838 the attention of the veterinary surgeons was drawn to that disease, and severe measures were taken with regard to it.

In 1852 the Government sent for Dutch veterinary surgeons especially with a view to enlisting their services in the campaign against cattle-plague. The results were that in about 1886 the disease was stamped out in Java. In Sumatra it remained prevalent a long time; and danger seems still to be threatening from Atjeh and British-India. The last great mortality took place in the Batak-countries, where, owing to rigorous measures, the disease was finally stamped out in about 1908—1910. Relatively few researches were made. DRIESSEN and others did supply several contributions towards cattle-plague-geography, and means of combating the disease, but researches into the nature of the disease are very scarce. PENNING showed experimentally that the pig is susceptible to cattle-plague virus; in 1906 these experiments were repeated by DE DOES, who confirmed PENNING's results. In 1902 ROLL and DE DOES made known their experiments with regard to immunization against cattle-plague. DE DOES, SOHNS and VRIJBURG contributed valuable information on the course of the disease in Sumatra among buffaloes, cattle and pigs.

Of historic interest is the controversy on the so-called oedematic form of cattle-plague, which disease used to be mixed up with the septicaemia haemorrhagica of the buffalo.

When importing cattle from British India the possibility of importing cattle-plague with it is always reckoned with, and therefore these animals are beforehand injected with immune serum.

After 1911 cattle-plague is not much mentioned in the Indian veterinary literature. In 1911 SOHNS records his campaign against it in the Batak-lands, when he practically succeeded in checking the disease, but he recommends watchfulness, as cases of cattle-plague still occur in the adjacent regions.

In 1920 VAN LIER describes a disease in the Karo-lands which he takes to be cattle-plague, or a disease resembling cattle-plague.

### Literature.

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Bijdrage tot de runderpest-geographie. D. Driessen. V. B. v. N. I. Deel 3, pag. 350.

Runderpest in Nederlandsch Indië. C. A. Penning. V. B. v. N. I. Deel 6, pag. 19.

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Veepest of een op veepest gelijkende ziekte in de Karolanden. Dr. G. A. van Lier. N. I. B. v. Dg. en Dt. Deel 32, pag. 438.

## ANTHRAX.

Anthrax was also diagnosed in the Indies at an early date. In the pre-bacteriologic times diseases such as cattle-plague, septicaemia, and others, had been, of course, mixed up with it, the more so as anthrax can assume a very severely epizoötical character in some parts of the Indies.

Very little has been published in the Indian literature with regard to anthrax.

In 1909 I observed a very serious anthrax epizoöty in Djambi and Palembang; the extremely boggy condition of the area, and the fact that the buffaloes live a semi-savage existence in those regions, render it practically impossible to combat the disease. It could be more succesfully dealt with in Benkulen, and throughout the remaining part of Sumatra's West-coast, as well as in Java and in the small Sunda-Islands, where the disease is combatted by applying modern methods of immunization (serum- and vaccine-injections according to Sobernheim).

In Roti, Bima and Krawang outbreaks of this disease were soon checked.

Experiments in the matter of cuti-vaccination against anthrax were started in 1927, and they are being continued.

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Een en ander over de geschiedenis van en den strijd tegen miltvuur op het eiland Roti. M. SOEPARWI. N. I. B. v. Dg. en Dt. Deel 36, pag.

Peracuut miltvuur bij karbouwen. K. H. EIJKMAN. N. I. B. v. Dg. en Dt. Deel 37, pag. 483.

## SEPTICAEMIA HAEMORRHAGICA OF THE BUFFALO.

This disease was for the first time described and aetiologically explained by VAN EECKE in 1890, in Western Java; this was with regard to the so-called exanthematic form of it, while in 1894 the pectoral form was observed by him. In 1900 GRIJNS also gives information on this disease in Tjibarusa. Epizoötiological observations and descriptions were published by FISCHER, HUBENET, and B. VRIJBURG. PENNING and SOHNS write about various types of this disease. The disease was also diagnosed in cattle.

Up to about 1911 the disease was exclusively combatted by keeping the infected herds in the "Kraals", by taking hygienic measures concerning the destruction of the dead bodies and by slaughtering the diseased animals in the early stages of the disease.

In 1909 DE BLIECK started preparing a serum against Baccillus bubalisepticus, while extensive experiments were conducted with a view to obtaining active immunization by means of simultaneous inoculation (serum and living or attenuated cultures, later killed cultures). The method could only gradually be carried through in practice.

In 1923 HUBER writes an extensive literature-survey of what had been done in the various countries and especially in the Indies with reference to immunization against septicaemia haemorrhagica, of the buffaloes in particular. In 1926 this veterinary surgeon published the results of his researches, conducted in the laboratory and in the course of his practical work with regard to active immunization of rabbits and buffaloes with killed vaccines and aggressines, and he obtained the same relatively favourable results as DE BLIECK, SMIT, BUBBERMAN and VERMEER.

HUBER proved that buffaloes and horses give more active sera than cattle. Normal-serum of the Sumbawa buffalo appeared to be as active as immune-serum. The cause of this will be investigated later.

BUBBERMAN imparts that in 1926 at Bantam an extensive experiment was again conducted with 48 hours old bouillon cultures, killed by formaline, and shaken during 48 hours, in order to render the vaccine rich in endotoxins.

It is evident that active immunization does not yet give entirely satisfactory results, although sufficient active immunity is to be obtained

in experimental research. The Veterinary Institute remains however always active and prepared in these matters.

It is BUBBERMAN's intention to immunize the buffaloes actively for the next wet season during the dry monsoon, when the disease does not, or rarely occur. Very probably it will prove necessary to apply repeated vaccine-inoculations, as is the case in fowl-cholera, when one single inoculation does not effect sufficient immunity, while inoculation applied twice or three times with vaccine containing many endotoxins guarantees an, on the whole, sufficient immunity against spontaneous infection.

### Literature.

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Pectorale vorm van Septicaemia haemorrhagica. VAN EECKE. V. B. v. N. I. Deel 9, pag. 300.

Exanthematische vorm van septicaemia haemorrhagica (sakit ngorok). FISCHER. V. B. v. N. I. Deel 10, pag. 192.

Barbone (Septicaemia epizöotica). B. VRIJBURG. V. B. v. N. I. Deel 17, pag. 66.

Het een en ander omtrent verschillende vormen van septicaemie bij den buffel in Ned. Indië. PENNING. V. B. v. N. I. Deel 18, pag. 288.

Nog iets over verschillende vormen van septicaemie bij buffels. SOHNS. V. B. v. N. I. Deel 20, pag. 129.

L. DE BLIECK. Jaarboeken Dep. van Landbouw 1909—1915.

Over immunisatie tegen septicaemia haemorrhagica in het bijzonder bij Indische buffels. Dr. F. L. HUBER. N. I. B. v. Dg. en Dt. Deel 34, pag. 402 en Deel 36 pag. 256.

Mededeelingen omtrent septicaemia epizoötica bij buffels op het eiland Soembawa, speciaal in het ressort Raba. A. P. LE COULTRE. N. I. B. v. Dg. en Dt. Deel 37, pag. 96.

## MALLEUS (GLANDERS).

Malleus also is one of those diseases, which were diagnosed during the first years that there were veterinary surgeons in the Indies.

BOSMA was the first to comment on the occurrence of malleus in the Netherlands Indies in 1889.

In 1893 PENNING conducted therapeutic experiments with iodine injections, while VAN VELZEN used malleïn for the first time. Subsequent researches were chiefly made with reference to the diagnostic of occult malleus by means of subcutaneous malleïn-test (HOOGKAMER, v. d. POEL, PENNING, v. d. BURG).

In 1906 DE HAAN and HOOGKAMER improve this diagnostic method by proving the rise in temperature on the second day after injection of malleïn to be an important and significant factor when diagnosing the case. Yet the subcutaneous application of malleïn by the Civil Veterinary Service proved unsuitable.

In 1907 and 1908 DE HAAN published his researches with reference to the complement fixation method for the diagnosis of glanders.

In 1909 DE BLIECK published an article, which appeared under No. 1a in the veterinary publications of the Department of Agriculture, and which treated of comparative researches into methods of diagnosing glanders; he introduced the ophthalmic test, which together with serologic test (complement fixation) has become the customary method used in diagnosing glanders.

DE HAAN and VAN DEN BURG also controlled the value of praecipitine-reaction.

DE BLIECK and BUBBERMAN have conducted extensive experiments in the matter of immunization against malleus by means of killed cultures and the vaccine "farase". They are arriving at the conclusion that it is possible to effect a partial immunization, particularly with „farase"; it would be advisable to do experiments in practise in order to support the measures taken towards combating the disease.

The combating of glanders forms part of the principal activities of the veterinary surgeons in the Indies.

## Literature.


Kwadedroes in Ned. Indië. K. BOSMA. V. B. v. N. I. Deel 3, pag. 105.

Proeven met Malleïne als diagnostikum bij occulten kwaden droes. P. A. VAN VELZEN. V. B. v. N. I. Deel 7, pag. 50.

Proeven met malleïne. L. J. HOOGKRAMER. V. B. v. N. I. Deel 8, pag. 1 (afl. 2).

Malleïne-inspuitingen in Bandjernegara. J. K. F. DE DOES. G. T. v. N. I. 1900.

Bijdrage tot de kennis van malleïne als diagnosticum bij kwaden droes. J. DE HAAN en L. J. HOOGKAMER. G. T. v. N. I. 1906.

De methode der complementbinding ter herkenning van kwade droes. J. DE HAAN. G. T. v. N. N. I. 1907 en 1908.

Welke waarde moet gehecht worden aan het gebruik van malleïne voor de bestrijding van malleus in Ned. Indië. W. VAN DER BURG. V. B. v. N. I. Deel 20, pag. 44.

Vergelijkende onderzoekingen naar de onderkenningsmiddelen van kwaden droes. Dr. L. DE BLIECK. Veeartsenijk. Mededeel. Dep. van Landbouw, 1909.

De praecipitine-reactie bij kwade droes. Dr. J. DE HAAN en W. VAN DER BURG. G. T. v. N. I. 1910.

Kwadedroes-infectie in verband met de conjunctivale malleïnatie en agglutinatie. Dr. L. DE BLIECK. Veeartsenijk. Mededeel. Dep. van Landbouw, 1911.

Immunisatie tegen Malleus. L. DE BLIECK en C. BUBBERMAN. Veeartsenijk. Mededeel. Dep. van Landbouw, 1912.

Het diagnotisch mallens-onderzoek in Ned. Indië, in het bijzonder met betrekking tot de jaren 1910 en 1911. Dr. L. DE BLIECK. Veeartsenijk. Mededeel. Dep. van Landbouw, 1913.

De waarde van het opnemen der lichaamstemperatuur tijdens de ophthalmomalleïnatie. C. BUBBERMAN. Veeartsenijk. Mededeel. Dep. van Landbouw, 1915.

Kan clinische mallens genezen? W. v. d. BURG. V. B. v. N. I. Deel 24, pag. 274.

## LYMPHANGITIS EPIZOÖTICA OF THE ONE-HOOFED ANIMALS.

In 1900 this disease was for the first time diagnosed in the Indies by DE DOES and DE HAAN; and in doing so they contributed considerably towards the knowledge of the differential diagnosis of glanders.

They succeeded in showing the saccharomyces in the pus, and in cultivating this germ; they also indicated the therapy, consisting principally of surgical treatment supported by caustics, which caused an increased secretion of the wounds.

ROLL and DE DOES diagnose this disease as an affection of the testicles; DE DOES also found saccharomycosis of the lungs.

The attention of the veterinary surgeons was particularly drawn to an improvement in the method of treatment.

J. H. ZIJP obtained favourable results with injections of jodipine near the affected parts of the skin, while also applying internal and external iodine therapy.

WITKAMP points at the good effect of intervenous injections of novarseno-benzol; he does not, however, wish to omit surgical treatment.

In 1922 BUBBERMAN draws the attention to the immune-therapy, while HUBER carries out a series of experiments in connection with this mode of treatment. They obtain success with repeated injections of cryptococcus-vaccines and could effect a cure without any other treatment. The results very much depend on the stage of the disease, and on the general condition of the patient. Living vaccine was more effective than dead vaccine; yet this method does not offer more practical advantages than surgical treatment combined with chemo-therapy.

### Literature.

Pseudo-malleus van de testikels. H. F. ROLL en J. K. F. DE DOES. G. T. v. N. I. 1902.

Pseudo-malleus of goedaardige huidworm. DE DOES en DE HAAN. V. B. v. N. I. Deel 13, pag. 375.

Saccharomyces-cellen in de long van een paard. J. K. F. DE DOES. G. T. v. N. I. 1905.

Jodipine bij farcinosis saccharomycotica. J. H. ZIJP. V. B. v. N. I. Deel 23, pag. 286.

Over de immunotherapie bij saccharomyces farciminosis. C. BUBBERMAN. N. I. B. v. Dg. en Dt. Deel 33, pag. 85.

De behandeling van saccharomycosis bij het paard met Novarsenobenzol. J. WITKAMP. N. I. B. v. Dg. en Dt. Afl. 1. Deel 37, pag. 65.

Over de immunotherapie bij lymphangitis epizoötica van het paard. C. BUBBERMAN en F. L. HUBER. Deel 37, pag. 369, 437 en pag. 516.

## TUBERCULOSIS.

As this disease is of less occurence in our colonies, the research-work in connection with it is little.

Among the indigenous cattle tuberculosis practically does not occur; the disease has been imported with European and Australian cattle, and remains principally confined to the dairy-cattle stables.

An official inquiry in 1902 did not produce one single positive answer with reference to the occurrence of tuberculosis among native-bred cattle, and only one case had been observed among Dutch cattle.

'T HOEN made a first experiment with tuberculin of a stock of cattle at Pajakoemboeh; he did not come across a single positive reaction.

DE HAAN proved in 1904 that the indian cattle are susceptible to tuberculosis; he obtained positive results when infecting Javanese goats, cattle and horses tubercle-bacilli of man.

The tuberculin test was not much applied by veterinary authorities in the Indies. In 1908 the Veterinary Laboratory prepared tuberculin with which DE BLIECK and VAN VELZEN applied ophthalmic tuberculination. The results were favourable, as, owing to the inconstant body-temperature of the imported cattle and the difficulty to judge of subcutaneous tuberculin test, the conjunctival method (with sensibilization) has always been used in the Indies since 1908.

DE BLIECK also suggested measures to combat the disease in the Indies.

In 1911 DE BLIECK and SMIT discovered tuberculosis in buffaloes which had been grazing with tuberculous cattle; remarkable was the slight extension of the processes in these animals, while the cultures appeared to be very little virulent for the calves of cattle.

VAN LIER, DOEVE and MOHEDE write on the combating of tuberculosis.

KOK and ROESLI observed extra-ordinary multiple skin-tumours in which acidproof bar shaped bodies were found which resembled tubercle bacilli; inoculations on animals did not however confirm the diagnosis of tuberculosis.

### Literature.

Proeven met tuberculine. 'T HOEN. V. B. v. N. I. Deel 14, pag. 216.

Experimenteele Tuberculose en rasimmuniteit. J. DE HAAN. B. V. v. N. I. Deel 16, pag. 364.

Besmetting van een zoogdier met vogeltuberculose. J. DE HAAN. G. T. v. N. I. 1906.

Verdere onderzoekingen omtrent tuberculose en tuberculinatie in Ned. Indië. L. DE BLIECK en H. J. SMIT. V. B. v. N. I. Deel 23, pag. 17.

Bestrijding van tuberculose in het ressort Soerabaja. H. VAN LIER. N. I. B. v. Dg. en Dt. Deel 34, pag. 82.

Tuberculose-onderzoek en bestrijding in den ambtskring Malang, van October 1923 tot en met Juli 1925. C. W. A. DOEVE en J. F. MOHEDE. N. I. B. v. Dg. en Dt. Deel 38, pag. 115 en pag. 228.

Huid-tuberculose(?) bij buffels. J. KOK en M. ROESLI. N. I. B. v. Dg. en Dt. Deel 38, pag. 465.

Of infectious diseases caused by bacteria a few must still be mentioned: viz: Blackleg, „Farcin du Boeuf", and Osteomyelitis bacillosa

## BLACKLEG.

In 1905 A. DE VLETTER diagnosed this disease for the first time along the North Coast of Rembang. In Modjokerto too cases were reported. During a considerable time the disease was not made any mention of. In 1914 VERMAST came across the disease in the Residency of Djocjacarta, and the diagnosis was bacteriologically confirmed at the Veterinary Laboratory. From that time onwards blackleg has been regularly diagnosed in the Residencies of Surakarta, Madiun, Surabaja, Madura and Rembang. The mortality is considerable, and not only the young, but also the older animals get affected, cattle as well as buffaloes.

In 1914 DE BLIECK prepared at the Veterinary Laboratory the vaccine of ARLOING, CORNEVIN and THOMAS; this has been successfully applied by the Veterinary Service. SOHNS experimented with the vaccination according to LECLAINCHE and VALLÉE, but the results in the Indies were not satisfying. From 1918 onwards experiments have been made with NAOSHI NITTA's filtrate-vaccine, and this has been regularly applied since then.

In 1922 LUIJTJENS gives a good survey of comparative experiments in the matter of immunization; and in particular LECLAINCHE's method was compared with the one based upon filtrates of liver-broth cultures, experiments which decided altogether in favour of the latter. In 1926 625 Litres of the filtrate (for 62000 animals) were supplied, while 250 Litres of blackleg serum were applied as well in herds of cattle which were already affected.

### Literature.

Boutvuur in Ned. Indië. A. DE VLETTER. V. B. v. N. I. Deel 19, pag. 257.

Boutvuur in Ned. Indië. J. CH. F. SOHNS. Veeartsenijk. Mededeel. v. h. Dep. van Landbouw. 1914.

Boutvuur-enting in het bijzonder voor Ned. Indië. J. C. F. SOHNS. Veeartsenijk. Mededeel. v. h. Dep. van Landbouw. 1915.

Boutvuur en boutvuur-enting J. LUITJENS. N. I. B. v. Dg. en Dt. Deel 33, pag. 107.

## FARCIN DU BOEUF.

This disease was for the first time diagnosed by B. VRYBURG in Deli, in 1907 (*"Recueil de Médecine Vétérinaire"* 1907). It is a very chronic affection of the superficial lymphatic glands while in the skin and subcutis also abscesses are formed. Occasionally metastase of the lungs and eyes occurs; an affection of the foot may also go with it. In Deli and in other parts of Sumatra, and particularly among British Indian cattle the disease occurs enzoötically. VRIJBURG's great merit is to have accurately described and aetiologically explained this disease; a specific bacillus was cultivated by him with which infection- and immunization experiments have been made. VAN DER LAAN (*N. I. B. v. Dg. en Dt.*, volume 32) makes mention of the therapeutic results of "ferrum candens" in this disease. This author gives also a good survey of the most prevalent diseases in Deli, pointing in particular at the frequent occurrence of lamenes among cattle, which he takes to be "osteomalacia". In 1927 this articular disease, which occurs scattered throughout Sumatra's Eastcoast, was studied more in detail by KRANEVELD (V. M. No. 59); he proved a causal relation with the Abortion bacillus of Bang. The lack of lime and phosphor would act predisposingly. Here treatment as applied to infectious abortion is also successful. Abortus infectiosa also occurs in other parts of the Archipelago. A serum and vaccine for the treatment of this disease are also being prepared at the Veterinary Institute.

## OSTEOMYELITIS BACILLOSA BUBALARUM EPIZOÖTICA.

As far as is known, this remarkable disease has been exclusively observed in the Netherlands Indies, and it was recorded in 1903 by DE DOES (*G. T. v. N. I.*, 1903). In 1893 DE DOES came across it in Cheribon and at Java's North-Coast; it had been noticed for the first time as early as 1867. At a later date the disease was seen in Sumatra, while at present it chiefly occurs in Tapanuli, especially among semi-savage buffaloes; for the rest in Medan, Atjeh and at Sumatra's West-Coast.

DE DOES gave a complete clinical and pathological-anatomical analysis of this disease, but as far as the pathogenesis, the infection, and the aetiology are concerned many obscure points remain to be cleared up. DE DOES did indeed find a large bacillus forming spores and threads, which according to him resembles the blackleg bacillus, but attempts to make cultures of it failed.

## PLEUROPNEUMONIA CONTAGIOSA BOVUM.

A disease which has been of little occurrence in the Indies, but which seriously threatens the cattle-stock is the Lung-plague of the cattle (pleuropneumonia contagiosa bovum).

This disease occurs in Australia, and in consequence of the necessary importation of dairy-cattle from Australia it has been brought into our colony. The disease was diagnosed by DE BLIECK in 1911 among a stock of cattle in the mountains of Lawang, where it had already been spreading to some extent, also among the indigenous cattle. By immediately slaughtering the diseased animals and those suspected of infection, the pleuropneumonia was stamped out. Here the Veterinary Service can record a great success.

### Literature.

Longziekte (Pleuropneumonia Contagiosa Bovum) op Java. L. DE BLIECK. Veeartsenijk. Mededeel. Dep. v. Landbouw. 1911.

Rapport over de veeartsenijkundige toestanden in Australië. 1913. L. DE BLIECK.

## HOGCHOLERA.

This disease was diagnosed for the first time at Medan, and has spread towards the Batak Highlands.

Probably imported as early as 1908 from Swatow or Australia, the Bacillus suipestifer was isolated in the Medan Laboratory.

In 1912 DE BLIECK diagnosed the disease on the Karroo-plateau combined with Bacillus suisepticus infection. Filtrate experiments made in 1912 by DE BLIECK, and in 1913 by BUBBERMAN, produced negative results, but on epizoötiologic grounds both researches point at the existence of the virus. The examined material was not suitable towards finding the virus.

In 1917 a great mortality took place again in the province of Bengkalis. In 1918 DOEVE, who examined acute cases, discovered the filtratable virus. Up to the present the disease is being combated by police measures.

### Literature.

Jaarboek Dep. van Landbouw, 1912, 1913.

Een geval van varkenspest. A. VAN LIER. V. B. v. N. I. Deel 20, pag. 455.

Borstziekte der varkens (septichaemia suum) en varkenspest in Ned. Indië. J. C. F. SOHNS. Veeartsenijk. Mededeel. v. h. Dep. v. Landbouw. 1914.

Varkenspest op Sumatra's Oostkust. W. C. A. DOEVE. N. I. B. v. Dg. en Dt. Deel 31, pag. 283.

## TRYPANOSOMIASIS.

In the Netherlands Indies only 2 species of pathogenic trypanosomes have been discovered among our domestic animals: viz: the Tr. Evansi, the cause of "Surra", and the Tr. Equiperdum, cause of "dourine". Since 1897 Surra has been diagnosed in the Indies; and in the Residency of Semarang for the first time. PENNING describes the disease in 1900, and says that it was sure to occur in other parts of Java, and in other islands as well. He diagnosed the disease as Trypanosomiasis, and he described the parasite. Soon after a number of publications followed. In 1901 DE DOES gives a good survey of the trypanosomes which are found in Java. A. VRIJBURG, transmitted the "surra" also upon cattle, he also tried to transmit the parasites by means of ticks and lice, but the experiments produced negative results.

In 1899 DE DOES had already made mention of Surra trypanosomes in cattle and buffaloes. Very rightly this investigator points at the necessity of comparative studies on the trypanosomes of surra and nagana. The Tr. equiperdum was found in Sumedang (Preanger) by DE DOES in 1900, and described in 1902.

The source of the disease however has remained unknown so far.

DE DOES already pointed at the differences between surra and dourine, and between the Sumedang and the European dourine. The percentage of spontaneous cures (clinical) was much greater in the case of the Sumedang disease than in Europe. In 1906 B. VRIJBURG describes a few more cases of covering disease, and points out that it was erroneous to hold to the opinion that the disease should have been stamped out in 1901. In 1904 and 1905 it was also diagnosed in Krawang. Undoubtedly the dourine in the Indies is little infectious and has spread very little. After 1905 no more cases had been observed, until in 1913 LEURINK diagnosed the disease in a stallion of Preanger origin, which was under suspicion of surra. The course of the disease was very mild, but it showed the same symptoms as dourine. Searching inquiries were made in the Preanger but no more cases were found. Yet it is very probable that the disease still occurs in the Southern Preanger Districts among horses living in semi-savage conditions.

After DE DOES's researches this disease has not been studied any further, on account of the lack of good material. But the surra, which sometimes causes great losses, has always drawn the attention of the veterinary surgeons. In 1903 P. SCHAT made extensive researches into the infection caused by stomoxys calcitrans. He described in the stomoxys stages of development of the trypanosomes, which have not been confirmed by other investigators. For the rest his reports contain important epizoötiologic data and methods of treatment

The study of the transmitting insects had been postponed in the Indies until the institution of a parasitologic department in the Veterinary Institute at Buitenzorg. Before then KONINGSBERGER collected and described insects in 1903, which may be of importance in the spreading of surra (ticks, hippoboscidae, tabanidae, chrysops, stomoxys).

Therapeutic experiments were conducted by PENNING at an early date. When the arsenic therapy came to the fore, several researches were made also in the Indies. HELLEMANS drew the attention towards it; JERONIMUS obtained by means of the arsenic therapy a considerable extension of the course of the disease (*G. T. v. N. I.* 1910). In 1911 DE BLIECK published in the Annual report of the Board of Agriculture his experiments in the matter of the treatment and cure of horses, artificially infected with surra, when the therapy was started shortly after the infection. HOLMES' method (atoxyl and auripigment) was applied. In 1913 STAPENSEA effected first a cure in cases of spontaneous surra in horses, also applied according to HOLMES' method. A great improvement in the surra therapy and prophylaxis was arrived at by the application of the remedy Naganol (Bayer 205). From 1922 onwards experiments on a large scale have been made with this remedy by RODENWALT, DOUWES, BUBBERMAN, VAN BERGEN and LAGAS, on horses, as well as cattle and buffaloes.

In the case of cattle and buffaloes very favourable results for practice have been obtained with naganol, as far as the curative and prophylactic treatment are concerned; by which the means of combat against the surra epizooties in these animals have been considerably improved. In the initial stages of the disease horses could be cured with a combined treatment of naganol and atoxyl or tartarus emeticus in 25—30 %.

At DE BLIECK's suggestion the Government decided in 1914 to appoint a Zoölogist-parasitologist, particularly for the study of the surra and piroplasmosis problem. Owing to war-conditions, however, the first functionary, Dr. SCHUURMANS STEKHOVEN, was not appointed until April 1922 and he went home in 1923.

In 1925 Dr. O. NIESCHULZ entered upon his duties; in the „*Vakblad voor Biologie*" he wrote in October 1927 a detailed account on the work in this department. Chiefly a study was made of the plague by hippoboscidae and of the biological side of the surra problem. The biology of the hippoboscidae in Sumba was studied by SCHUURMANS STEKHOVEN, who also suggested a prophylaxis by dipping the horses in water mixed with paraffinoil.

SCHUURMANS STEKHOVEN systematically studied the tabanids and recorded the results of these studies in a detailed monograph. NIESCHULZ used these studies as a basis to start from and carried out transmission

experiments, which were successful in the case of 12 species of Tabanids (± 300 species are known in the Dutch Indies and neighbouring countries). These researches, which were comparatively difficult from a technical point of view, produced important scientific results.

With stomoxys the infection-experiments were negative.

NIESCHULZ moreover studied and described the habitat of the tabanids, together with the biology of 2 species of ichneumon-flies (Phanurus sp.), which infect the eggs of tabanids, and which, therefore, are their natural enemies.

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Over het voorkomen van Anaemia Perniciosa Infectiosa of wel Surra onder de paarden in Ned. Indië. C. A. PENNING. V. B. v. N. I. Deel 12, pag. 123.

Verdere waarnemingen betreffende surra in Ned. Indië. C. A. Penning. V. B. v. N. I. Deel 13, pag. 25.

Surra. A. VRIJBURG. V. B. v. N. I. Deel 13, pag. 53, deel 14, pag. 207.

Boosaardige dekziekte in het Soemedangsche. J. DE DOES. V. B. v. N. I. Deel 13, pag. 104 en Deel 14 pag. 20.

Bijdrage tot de kennis van Trypamosomenziekten in het bijzonder die, welke op Java voorkomen. J. K. F. DE DOES. V. B. v. N. I. Deel 13, pag. 313.

Over de insecten die mogelijkerwijze bij de verspreiding der surra een rol spelen. Dr. KONINGSBERGER. V. B. v. N. I. Deel 15, pag. 71.

Eenige mededeelingen over surra en omtrent onderzoekingen daarmede in verband staande. P. SCHAT. V. B. v. N. I. Deel 15, pag. 278.

Dekziekte in de Preanger Regentschappen. VRIJBURG. V. B. v. N. I. Deel 18, pag. 233.

Surra bij den hond. J. C. SOHNS. V. B. v. N. I. Deel 18, pag. 268.

Draaiziekte (Penjakit moeheng). SOHNS. V. B. v. N. I. Deel 19, pag. 463.

Salvarsan bij surra van het paard. J. H. ZIJP. V. B. v. N. I Deel 24, pag. 470.

Behandeling van surra met atoxyl en acidum arsenicosum. J. STAPENSEA. V. B. v. N. I. Deel 25, pag. 430.

Boosaardige dekziekte in de Preanger. G. LEURINK. V. M. v. h. Dep. v. Landbouw No. 9. 1913.

Over de toepassing van Bayer 205 by de surra van het paard in Ned. Indië. Prof. RODENWALT en J. B. BOUWENS. N. I. B. v. Dg. en Dt. Deel 33 afl. V en VI, pag. I en V. M. v. h. Dep. van Landbouw No. 33. 1922.

De behandeling van surra bij herkauwers met Bayer 205. J. B. DOUWES. N. I. B. v. Dg. en Dt. Deel 34, pag. I.

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Over de toepassing van Bayer 205 als hulpmiddel bij de bestrijding van surra bij karbouwen in de onderafdeeling Toba der Bataklanden. D. LAGAS. N. I. B. v. Dg. en Dt. Deel 37, pag. 279.

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Surra-overbrenging en biologie der tabaniden. V. M. v. h. Dep. van Landbouw 1925—1928. Dr. O. NIESCHULZ.

## PIROPLASMOSIS.

The first experience with reference to piroplasmosis in the East Indies dates back to the year 1896, when DE DOES found in buffaloes, which suffered from cattle-plague, a Piroplasma resembling P. bigemina. In 1897—1898 haemoglobinuria was diagnosed in cattle at Batavia, Tegal and Lembang, and P. bigemina was found. In 1897 DE DOES made also mention of small thread-like and coccus-like parasites; the latter resembled those which had been recorded by SMITH and KILBORNE in chronic Texas fever and which in 1910 were classified by THEILER as separate parasites (anaplasma) In 1906 DE DOES published a very accurate study on piroplasmosis in thin calves at Batavia; there also P. bigemina were found together with tread-like and coccus-like parasites. DE DOES took the thread-like parasites to be the cause of the disease, and left the other-ones out of the discussion. On the ground of morphological resemblance the first-mentioned were considered to be Theileria parva.

From a clinical and pathologic-anatomical point of view, however, the disease differed considerably from Theileriasis and showed, according to DE DOES, more resemblance with the cachectic form of the piroplasmosis in Trans-Caucasus.

In the course of experiments, made at the Veterinary Laboratory at Buitenzorg, DE BLIECK stated that the above mentioned cachectic calves and cattle suffering from piroplasmosis did not show the Koch-bodies in the spleen- and lymphatic glands characteristic to Theileria parva, and that the thread-like piroplasma is to be considered identical with THEILER'S Gonderia mutans, which, however, was not yet known in 1906. Theileria parva does not occur in the Indies.

In 1906 PENNING provisionally reported cases of piroplasmosis in imported Australian cattle at Semarang; they all ran acute courses and ended in death without haemoglobinuria. A pointed piroplasma, which is probably identical with Anaplasma marginale was taken to be the cause of this disease.

After 1906 no further communications were made for a long time. But immediately after the diagnosis of Texas fever in 1898 an inquiry was made into the occurrence of ticks on our domestic animals in the Netherlands Indies. In 1903 KONINGSBERGER determined and described two kinds of ticks on cattle and buffaloes, the Boophilus Australis and the Amblyomma Testudinarium. Out of a collection of specimens, sent in at a later date, NUTTALL at Cambridge determined among ticks of mammals and birds four more species, parasitizing on cattle and buffalo, while four species living on the dog were found also.

From 1911 onwards DE BLIECK has been systematically conducting infection-experiments with piroplasms, and now it has been stated that P. bigeminum, G. mutans and Anaplasma marginale in cattle and buffalo are found in the Indies The buffalo piroplasm do not go over upon cattle. In 1922 KALIGIS wrote a thesis on Anaplasmosis in cattle and buffalo, in which he also treated of the problem wether anaplasma is a parasite or not.

DE BLIECK also initiated the campaign against ticks; he instituted his immunization experiments in the matter of Anaplasmosis. At the present day BUBBERMAN is conducting immunization experiments with Anaplasma centrale, the less virulent variety.

WIRTH suggests according to THEILER the preparation of an inexpensive dipping against ticks made up of the so-called "Warangan" (90 % $As^2 O^3$) and Soda.

In the Indies no piroplasm have been found in horse, sheep or goat; but in the dog P. canis occurs. WITKAMP wrote a good monograph on the subject and came to the conclusion that this disease is endemic in the Indies and is transmitted by Rhipicephalus sanguineus. By means of splenectomy he proved that piroplasmosis occurs latent in native dogs.

Among the bloodprotozoa remains to be mentioned the Spirochaeta Theileri, observed by DE BLIECK in 1915.

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Onderzoek naar het bestaan van een toestand van labiele infectie ten opzichte naarp iroplasmosis canis bij inheemsche honden. J. WITKAMP N. I. B. v. Dg. en Dt. Deel 37, pag. 385.

## PHYTOPARASITICAL DISEASES.

Of these a very remarkable one is found in the Indies: e.g. Hyphomycosis Destruens.

In 1900 this typical disease of the horse was for the first time described by DE HAAN and HOOGKAMER; in peculiar pathological alterations they found a fungus-mycelium which they considered the cause, and this was confirmed by WITKAMP in the course of extensive researches. HOOGKAMER and DE HAAN also cultivated the fungus. For the rest a few casuistic publications appeared.

In 1924 WITKAMP further analysed this disease from an aetiological point of view, comparing it with similar mycosis of animals and men. Prophylaxis, pathological histology, modus of infection, pathogenesis, diagnostics, also by means of allergic reactions and serological examination, as well as the therapy of this disease have been fully explained in this thesis.

Trichophyty and Microspory have been especially studied by DE DOES, while in 1920 BUBBERMAN wrote a thesis on microspory, in particular with reference to the goat. This disease is caused by the Microsporum Audouini var. hemitragi, which belongs to the humane types and is said to originale from a child's head.

The West-Javanese goats are susceptible to this microsporon, which was originally imported with goats from British India.

### Literature.

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Herpes tonsurans en microsporie bij Australische paarden. J. K. F. DE DOES. G. T. v. N. I. 1903.

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## ZOÖPARASITOSEN.

Apart from the already mentioned protozolocial diseases many other Zoöparasites and diseases, caused by them, are known in the Indies and have been further studied.

VAN EECKE wrote in 1893 on Sarcosporidies; in 1894 PENNING records the occurrence of Setaria papillosa in the horse, Spirocerca sanguinolenta and Dirofilaria immitis in the dog; in 1898 VRIJBURG found the Elaephora Poeli in the aorta-wall of buffalo and cattle.

In 1912 HELLEMANS made extensive researches into the occurrence of Stephanurus dentatus in pigs in Java and Sumatra.

NOORDHOEK HEGT, ARNTZ, v. d. SCHROEFF, SOHNS and TREFFERS have increased our knowledge about Trematodes and Nematodes in the Indies.

After 1919 the subject of worms and helminthiasis have been nearly exclusively and very successfully studied by Dr. H. J. SMIT and R. NOTO SODOERO, who have discovered a number of new species. Of importance are among others their researches into strongylides of the horse. For the sake of brevity I refer to the "*Veeartsenijkundige bladen v. N. I.*" volumes 30—39 inclusive.

In volume 38 of the *V. B. v. N. I.*, SMIT wrote out a list of all the worms found in the Indies up to 1926 in the different kinds of domestic animals, whereby references are made to the literature in question. An extensive collection of these parasites is to be found at the Veterinary College at Buitenzorg.

Special mention must be made also of DE DOES's researches into Dermofilaria irritans (1905), Habronema microstoma and megastoma, as well as of the description of a skin-disease on cattle in Deli, the so-called Dermatitis verminosa pruriens bovis (1910), which is caused by worms.

A short time ago LE COULTRE made researches into occurrence of Cysticerci in cattle and pigs in Bali, a study which is of much importance with reference to human hygiene. In 1928 an extensive monograph on this subject appeared as thesis.

Several other diseases by arthropodes besides the ones already mentioned, have been described, among others several scabies mites.

## Literature.


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Dermatitis Verminosa pruriens bovis. J. K. F. DE DOES. G. T. v. N. I. 1910.

Acarusschurft bij het rund. J. BREEDVELD. V. B. v. N. I. Deel 22, pag. 43.

Sarcoptesschurft bij karbouwen. P. ZIJP. V. B. v. N. I. Deel 22, pag. 358.

Ueber das auftreten der Strongylus pinguicola auf Java und Sumatra. J. HELLEMANS. V. B. v. N. I. Deel 24, pag. 213.

Wormziekte bij geiten. H. J. v. d. SCHROEFF. V. B. v. N. I. Deel 27, pag 369 en 419.

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Cysticerci in het vleesch van rund en varken. A. P. LE COULTRE. Proefschrift. Utrecht 1928.

Parasitologische Mededeelingen. H. J. SMIT en R. NOTO SODIRO. V. B. v. N. I. Deel 30—39.

## POULTRY DISEASES.

During these last years the study of poultry diseases has also been taken up at the Veterinary Institute.

Fowl-cholera and several worm-diseases were already known in the Indies, while tuberculosis and pox-diphtheria had been diagnosed.

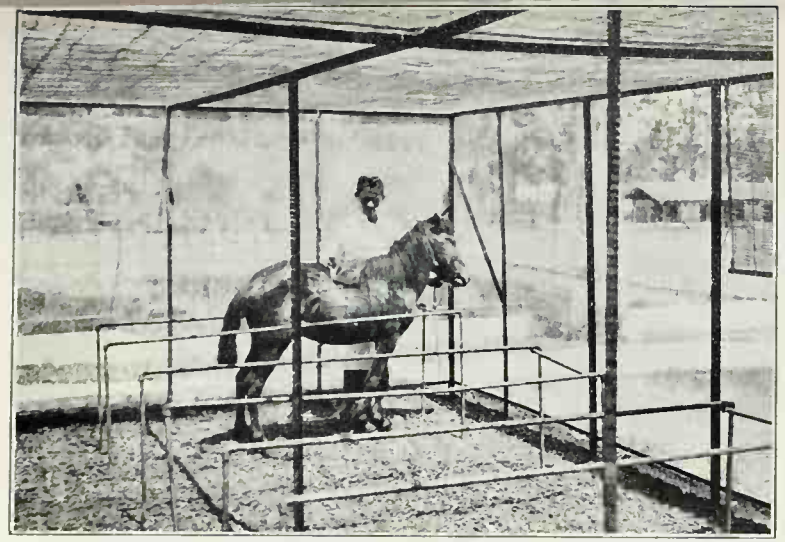
PICARD made extensive researches into disease among fowls, which caused a very great mortality, and which was diagnosed by him as Pseudo-fowl plague, a disease described by DOYLE in England a few years ago under the name of „Newcastle Disease". PICARD described these researches in the *„V. M. v. h. Dep. van Landbouw"* No. 65 (1928).

One of the laboratories of the Veterinary Institute.

Course of histology and bacteriology at the Veterinary College.

Main building of the Veterinary College at Buitenzorg.

Some of the Experiment stables of the Veterinary Institute.



Stable for Surra-transmission Experiments at the Veterinary Institute.

Immunisation against Septicaemia haemorrhagica.

Polyclinic at the Veterinary College.

Immunisation of buffaloes against Anthrax in Sumatra.

Front-view of the Veterinary Institute at Buitenzorg.

# CHEMISTRY

by Dr. P. VAN ROMBURGH,
*Emer. Prof. of organic chemistry at the University of Utrecht.*

Although the Netherlands East Indies possess no Universities, but only a technical and a medical college, where chemistry is studied but as a secondary subject, this branch of science has indeed had many followers in the Indies since the beginning of the last century.

Up till the present time however only Europeans are found amongst them, the native population being apparently much more attracted to the study of languages, law and medicine than to the natural sciences; it would seem however, that in recent years there is a growing tendency towards the study of engineering. As far as the chemical laboratory requirements of routine work and practical skill are concerned, the natives, especially the Javanese, are in no way inferior to those engaged upon similar work in Europe and elsewhere; indeed their help is frequentiy highly valued by the European chemist, and it is quite unnecessary to import men from Holland for the performance of such work.

The first step in the direction of scientific research in the realm of chemistry was made (although unconsciously) by the foundation in 1778 of the "Bataviaasch Genootschap voor Kunsten en Wetenschappen". Due to the instigation of this society, the services of THOMAS HORSFIELD, an English physician, were obtained, who, upon his arrival at Java in the year 1802, was commissioned by the Government to undertake an investigation into the plants of medical value indigenous to the island. HORSFIELD did not restrict himself to botany alone, and amongst other subjects interested himself in chemical research; thus, he established the fact that the ashes ejected by Gunung Guntur, possessed approximately the same composition as lava or basalt; he also examined a mineral water and found it to be similar to Seltser water, and in no way inferior to it.

In 1818 the War Department erected a chemical laboratory at Weltevreden, the first in the Netherlands East Indies[1]). For many

[1]) This laboratory for the Medical Service of the Army has been removed just recently, to Bandung.

years this laboratory did little more than prepare compound medicaments and it was only after 1840, when chemistry began to flourish in Holland and when properly trained men where sent out from there, that the first chemical publications appeared in the Netherlands East Indies. These publications were concerned mainly with mineral waters, and as an instance may be mentioned MAIER's discovery of iodine in a spring at Surabaya. This discovery led to the exploitation of the iodine containing springs at Java, from which are now annually obtained many thousands of kilogrammes of cuprous iodide.

ALTHEER and ROST VAN TONNINGEN performed pioneering work in the domain of phytochemistry, as did BERNELOT MOENS, who among other things, found in the bark of Nauclea orientalis, a salt of an organic acid, which he named naucleinic acid, but which, as DE VRIJ subsequently showed, proved to be identical with quinoxic acid from cinchona bark. He also investigated getah melaboeai (related to jelutung) and demonstrated that it contained besides resins, rubber to an extent of 16.9 %.

Since agriculture forms the chief source of prosperity in the Netherlands East Indies, it goes without saying that when, in the middle of the last century, agricultural chemistry shared in the general development of chemistry in Europe, immediate use was made of its applications to agricultural problems in the Indies. In 1848 FROMBERG, who had spent three years as an assistant to Prof. JOHNSTON at Edinburgh, was sent out to Java in the capacity of agricultural chemist, and shortly afterwards the Government of the East Indies erected a laboratory for agricultural chemistry at Buitenzorg.

FROMBERG first devoted his attention to soil analysis in connection with the cultivation of coffee, from the results of which he came to the conclusion that the low humus content in the soils he examined could explain the death of coffee plants growing in the districts from where the samples had been taken. He also made a study of the culture and manufacture of sugar, and owing to the changes that the introduced, the yield and quality of the sugar were considerably improved.

After the death of FROMBERG in 1858, the work was carried on along similar lines by ROST VAN TONNINGEN, but in 1860 for some unknown reason, his laboratory was closed. About this time the Government erected another laboratory in connection with the young cinchona cultivation, which it had taken in hand since 1854. The first chemist in this laboratory was DE VRIJ who made his name by the work which he carried out on the quantitative determination of the cinchona alkaloids. In 1872 BERNELOT MOENS became chemist at the cinchona-laboratory, and in 1875 he was appointed Director of the Government

Cinchona Plantations. His work, especially that in connection with the selection of cinchona trees with a view to increasing the alkaloid content, has contributed in great measure to the prosperity of cinchona cultivation in Java. As author of the well known book "De kinacultuur in Azië van 1854—1882" [1]) he has earned an undying name in the realm of cinchona literature.

His work has been carried on along the same lines by his followers, and the cultivation of cinchona trees bearing a high percentage of alkaloids, has developed to such an extent that in cinchona bark, the Netherlands East Indies dominates the worlds market.

With the arrival of MELCHIOR TREUB as Director of the Buitenzorg Botanical Gardens there dawned a new era, not only for botanical science but also for chemistry.

Although himself a botanist he was fully alive to the importance that chemical research and applied chemistry must have to agriculture in the Netherlands East Indies. He realised that chemical science would be able to contribute in large measure to the phytochemical knowledge of the flora and soil of the Indies.

Phytochemistry, as we have seen, had already attracted investigators at Java, but a great stride forward was made when J. F. EIJKMAN upon his return to Europe in 1885 from Japan (where he had carried out many interesting researches in his capacity of professor at Tokio) paid a visit to the Botanical Gardens at Buitenzorg.

He at once found that TREUB was prepared to equip a small chemical laboratory for him, and thus was sown the seed from which sprang in a remarkable manner, a series of varied chemical investigations, which were always strongly supported and encouraged by TREUB himself.

Although EIJKMAN's visit to Java was of only four months duration, in this time he examined no fewer than 200 plants for alkaloids, and moreover undertook the investigation of the essential oil from Chavica Betle, which incidently led up to his well known refractometric researches. EIJKMAN also found that a species of Erythroxylon growing in the Botanical Gardens at Buitenzorg, possessed a high alkaloid content, (cinnamyl-cocaine) considerably higher indeed than that of Erythroxylon Coca. This discovery was the prime mover in establishing cocoa cultivation in Java.

Three years after EIJKMAN's visit, a pharmacological laboratory was connected with the Botanical Gardens, and in which GRESHOFF worked until 1892. During this time he carried out interesting pioneer work in the field of phytochemistry. More than 1000 different species

[1]) "The Cultivation of Cinchona in Asia from 1854 to 1882".

of plants were embraced in his investigations, in which he took natural relationship as his working principle. It is not possible here to give an in any way complete summary of his work, and it must suffice to quote only a few examples. From the leaves of Papaya, GRESHOFF isolated an alkaloid called carpaïne, which exerts an action upon the heart; from the roots of Derris elliptica, he obtained the powerful fish poison „derride", a discovery which induced him to write a monography about fish poisons in general. From the seeds of Hypaphorus subumbrans he obtained a well formed crystalline substance called hypaphorine which was subsequently investigated by G. BARGER and VAN ROMBURGH, who found it to represent a betaïne of tryptophane. He discovered that hydrocyanic acid occurred in many plants, being present in considerable quantity, both in the free and combined state, in Pangium edule. Later, DE JONG demonstrated the presence of the glucoside gynocardine in this plant. As a result of his investigations into Pangium, TREUB was led to undertake his important researches into the role played by hydrocyanic acid in the plant. From the results of these investigations he concluded that this simple compound was probably the first nitrogenous product to be formed in the plant by assimilation.

In 1892 W. G. BOORSMA succeeded GRESHOFF, and remained as Director of the laboratory until 1917. He directed the research work along the same lines as did his predecessor, and moreover devoted his attention to the investigation of the local medical remedies. In this case also only a few instances of his work will be given. From the bark of Plumiera acutifolia he obtained plumeride which he characterised as a bitter principle, FRANCHIMONT later establishing its glucosidal nature and identity with PECKOLT's agoniadine. Two alkaloids, dioscorine and dioscoreine, were obtained from Dioscorea hirsuta. EUCHRESTA HORSFIELDI appeared to contain a powerful poison, which was later recognised by PLUGGE as cytisine. Multitudinous are the plants in which BOORSMA met with bitter principles, tannins, alkaloids, saponins etc.; his attention was also directed towards the examination of odoriferous woods.

GORTER, who in 1917 succeeded him, was a born phytochemist. He made his debut in 1914 when attached to the coffee experimental station as chemist. Here he first studied chlorogenic acid and found that by the action of alkalis it was split up into coffee acid and cinchoninic acid. It was later demonstrated by FREUDENBERG that these two acids were combined in the manner of an ester, chlorogenic acid thus being a representative of EMIL FISCHER's depsides. Later, as Director of the laboratory for microbiology he investigated dioscorine, showing that besides possessing a cycloheptane ring, it had the characteristics of a lactone. He proposed a formula which threw some light upon

its relationship with eegonine. He further showed that the glucoside that is obtained from the seeds of Hevea brasiliensis and yields hydrocyanic acid and aeetone, was identieal with phaseolunatine (linamarine); in Fieus latex was found d-saecharie aeid in the form of its magnesium salt. A study of hyptolide, a bitter prineiple diseovered by BOORSMA in the leaves of Hyptis pestinata, showed this substanee to be a lactone, and moreover the ester of a tertiary alcohol, GORTER was thus able to establish its struetural formula. He also suceeeded in proving that lyeorine possesses an analagous strueture to that of hydrastine. Of great interest is the research conduеted by GORTER on the glucoside hiptagine from Hiptage Madablota Gaertn., showing it to be a derivative of isoxazol. Mention must also be made of GORTER's final researehes on laurotetanine, an alkaloid occuring in many Lauraeeae, and first isolated by GRESHOFF. He showed that when the alkaloid was methylated with diazomethane it was eonverted into isoglaueine, the struetural formula of whieh he established, and was thus able to propose two struetural formulae, one of whieh represented laurotetanine. The mother substanee of Indian Yellow, a eompound called mangiferine, isolated from the leaves of the Mangga, is aecording to GORTER, isomerie with euxanthinic aeid.

After GORTER, ULTÉE worked for some time in the phytoehemieal laboratory, where he eonducted researehes into the sterines.

In 1890 the Government founded for the second time a laboratory for agrieultural chemistry at Buitenzorg, VAN ROMBURGH being plaeed in eharge. He undertook numerous researehes in relation to the eultivation of plants, and besides phytochemieal work, he eontinued his researches upon the subjects that he had been pursuing in Holland. Some thousands of plants were investigated to determine whether they contained volatile substanees, and in a large number of eases methyl salicylate was found to occur. Methyl alcohol and acetone were also quite frequently encountered. From fresh tea leaves he was able to isolate methyl alcohol, while freshly fermented tea leaves on the other hand yielded besides methyl salicylate, hexene-3-ol-1. The rhizomes of Alpinia malaeeensis besides eontaining pinene appeared to be rich in methyl cinnamate, and in the rhizomes of Kaemferia Galanga were found p-methoxyethylcinnamate, ethyl cinnamate and pentadecane. From the leaves of Ocimum gratissimum there was obtained besides eugenol, an olefinic terpene, ocimene, which is isomerie with myreene. The leaves of Indigofera galegoides were found to contain no indigo, but yielded upon steam distillation, hydrocyanic acid and bitter almond oil.

A. W. K. DE JONG, who later assumed charge of the laboratory,

elaborated a method for determining the essential oil content of plants, and worked on the so-called "geraniol" estimation in citronella oil and the citral estimation in lemon grass oil, experimented on the fermentation of patchuli leaves and examined the possibility of preparing Ylang-Ylang from Indian Cananga flowers. The influence of drying citronella grass on the yield and quality of the oil was investigated. He also carried out interesting investigations into the formation of truxillic acids from cinnamic and allocinnamic acids by the action of sun light, and made

Agricultural Chemical Laboratory at Buitenzorg.

experiments in connection with the cultivation of coca, incidently working out a good method for the determination of coca-alkaloids, and found that upon the ageing of the leaf, the cocaine content increased while the cinnamyl-cocaine decreased; he isolated cocaine from old as well as from young leaves.

In other laboraties as well, chemists have directed their attention to the investigation of essential oils. Ultée obtained methyl cinnamate, cineol, and camphor from the essential oil of Alpinia Galanga Willd., and from Gastrochilus panduratum Ridl. oil the same substances as well as an olefinic terpene, which is probably myrcene. Weehuizen

has reported the presence of indol in a number of flowers, citral in a species of Ocimum, and carvacrol in Coleus amboinicus.

In the laboratory for marine investigations at Batavia, VAN WEEL instituted researches into the salinity of shallow seas.

At the bureau for commercial and agricultural analysis at Buitenzorg, thousands of samples are analysed every year.

In the Board-of-Health-Laboratory, where much routine work of an analytical nature in relation to foodstuffs is undertaken,

Experimental Station for Sugar at Pasuruan.

B. C. P. JANSEN and DONATH in 1926, after overcoming great practical difficulties, succeeded in isolating from rice husks the anti-berri-berri vitamine in a pure crystalline condition. The vitamine was found to possess the simple empirical formula $C_6H_{10}N_2O$ so one may foster the hope that they will also be successful in carrying out its synthesis.

In 1905 the Government commissioned L. G. DEN BERGER to conduct an investigation into rice and other plant foods. He studied principally problems dependant upon irrigation and in connection therewith examined the water of different rivers.

It thus becomes at once apparent, even from this cursory report,

to what a great extent the Government has been responsible by its erection of laboratories and appointment of chemists, for the promotion of chemical investigation in the Netherlands East Indies.

Apart from the laboratories under Government jurisdiction, the Netherlands East Indies also possess a large number of laboratories erected by private enterprise by those whose interests lie in the cultivation of various plants.

Thus one finds at the present time excellently equipped experimental

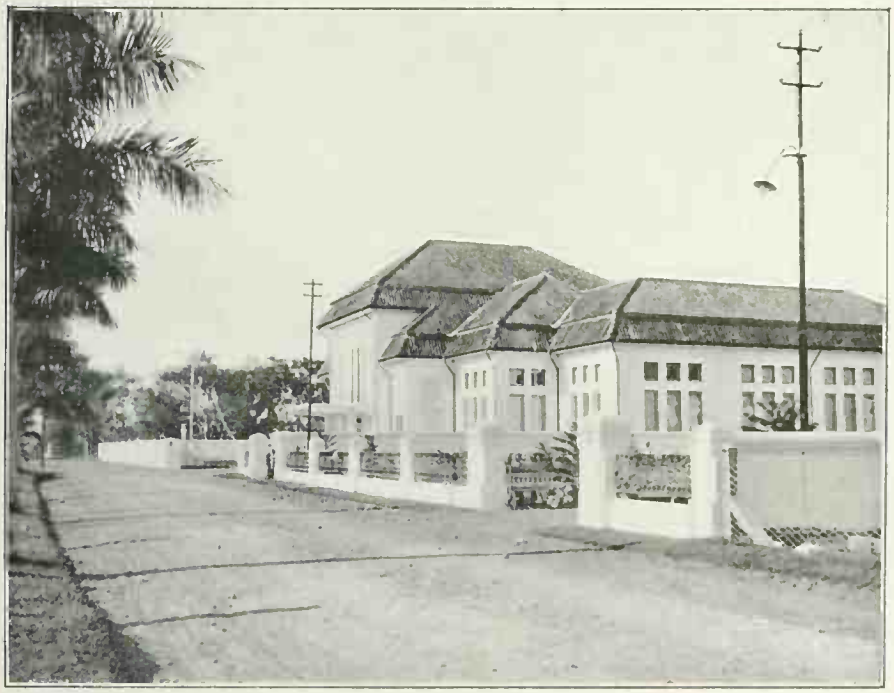
Experimental Station for Sugar at Pekalongan.

stations, where room is also made for research work; in Java for instance, at Pasuruan and Pekalongan there is a sugar Experimental station, at Malang one for coffee, rubber and tobacco, at Djember one for tobacco and rubber, at Buitenzorg one for tea and one exclusively for rubber, at Klaten one for tobacco, and at Medan in Sumatra is a laboratory for Delitobacco and one for rubber, coffee and palm oils, called the "Avros" laboratory.

Furthermore there are still the privately owned laboratories belonging to agricultural companies; indeed there are few tropical countries where more chemical work is carried on in connection with agriculture and the industries pertaining thereto. The petroleum industry has its laboratories also, in which research work is carried on, the results however, are not made public.

The chemical laboratories of the Experimental stations undertake the examination of soil samples, important work that has contributed in large degree to the information collected about the soil used for agricultural purposes in the Indies.

The sugar-planters led the way in instituting special Experimental stations. When the "sereh" disease commenced to devastate the sugar plantations, the owners of the factories erected in 1886 two stations, each directed by a botanist. In 1887 another station was established



Experimental Station for "mountain"-cultures at Malang.

having a chemist as its director. At the commencement most attention was paid to the investigation of soils and manures, but soon followed cane analyses in relation to age and fertilisation of the cane, in order that a choice of the best varieties of cane might be facilitated.

Chemists were kept busily employed conducting researches with a view to effecting improvements in the manufacture of sugar. A brief summary of the work accomplished in this direction since 1887 would fill a book, and detailed results are to be found in the *Archief voor de Suikerindustrie* a journal which has now reached its 36th. year. It must

suffice here to mention only a few names of the many workers in this field, a field embracing all branches of chemistry.

First comes the epoc making work of PRINSEN GEERLIGS and others in connection with the formation of molasses during the manufacture of cane sugar. From his experiments he arrived at the conclusion that molasses is a compound containing water, sugars and salts, which cannot be separated by concentration of its solution, consequently no

Experimental Station for Deli-tobacco at Medan.

saccharose can be obtained therefrom in a crystalline condition. PRINSEN GEERLIGS also investigated the action of lime and baryta on glucose, and discovered amongst other things that a strong solution of caustic potash caused the formation of saccharic acid, while in the case of lime or baryta the effect was to produce "canna acid". He showed that the action of lime on the cell walls of the sugar cane led to the production of pectines. His research into cane-wax showed that this substance contained an alcohol of high molecular weight, which yielded an unsaturated hydrocarbon when heated with soda lime. We have also PRINSEN GEERLIGS to thank for the introduction of "mutual works control"

which at the present time has been adopted by almost all factories.

WENT investigated the sugar cane from the standpoint of the physiological chemist. T. VAN DER LINDEN made a study of molasses formation on the basis of the phase rule, he also worked on the decomposition of glucose and the products arising therefrom, the formation of molasses and the possibilities of sugar recovery from it. Within recent years the investigation of soils has again come to the fore.

General Experimental Station of the „AVROS" at Medan.

After the setting up of the laboratory for agricultural chemistry at Buitenzorg, investigations into tea were taken in hand by VAN ROMBURGH, who was joined in 1893 at the expense of some of the tea planters, by LOHMANN as his assistant. The withering and fermentation of tea was studied, and it was found that during the process, oxygen was absorbed and carbon dioxide liberated, the presence of lower organisms being apparently unnecessary for the process. The constituents of tea leaves and the changes that they undergo during manufacture were also subjects of research which were continued later by NANNINGA who succeeded in isolating l-tannic acid besides a glucoside containing

potassium from tea leaves, and also showed theobromine to be a further constituent.

In 1902 the Sukabumi Agricultural Society erected a tea experimental station, at which the oxidising ferment of tea was studied by WELTER, and later the peroxidase and tannin of tea by DEUSS. In 1927 a large new tea experimental station was opened at Buitenzorg.

In former days the indigo and coffee plantations also had their laboratories. HAZEWINKEL, working in the laboratory for indigo, isolated the glucoside indican from indigo leaves. This glucoside was found to be hydrolysed by an enzyme to produce glucose and indoxyl, oxidation of the latter yielding indigo blue besides some indigo red.

In the laboratory for coffee investigation, GORTER, as already mentioned, isolated chlorogenic acid; he also showed that by the fermentation of fresh coffee beans, amongst other substances, lactic acid was formed.

The chemical investigation of tobacco was commenced at Buitenzorg in 1894 when the director of the 's Lands Plantentuin had a sum of money put at his disposal for the purpose by the Deli planters. In 1906 the connection with Buitenzorg was severed, the Deli planters erecting an experimental station of their own at Medan. Much useful work was achieved for the Deli tobacco by VAN BYLERT, MOHR and HISSINK, who considerably enriched our knowledge of the soils from the tobacco plantations, and provided improvements in the methods for the manufacture of tobacco. In Java, as well as at the Experimental station for Vorstenland tobacco, and at the station at Besoeki, many subjects have been investigated. O. DE VRIES was engaged with soil investigations and with drying and fermentation tests. N. H. COHEN worked on the combustibility and fermentation of tobacco. E. SIDENIUS introduced a quick fermentation process, and ULTÉE at Besoeki worked along the same lines as the other stations.

Rubber investigations began in 1890 in the laboratory for agricultural chemistry at Buitenzorg, where VAN ROMBURGH studied the various kinds of rubber growing there. By steam distilling the leaves and seeds of Hevea brasiliensis he obtained acetone and hydrocyanic acid. A. W. K. DE JONG and TROMP DE HAAS established the fact that rubber is already present as such in the latex of Hevea, and is not formed subsequently by the polymerisation of a simple hydrocarbon. DE JONG was the first to isolate quebrachitol from latex, and also found i-dimethylinositol to occur in Dyera latex. KERBOSCH found traces of hydrocyanic acid and acetaldehyde in Hevea latex. ULTÉE succeeded in separating $\alpha$-amyrine acetate, from the rubber of Ficus elastica, $\alpha$-amyrine acetate, lupeol acetate and $\beta$-amyrine in the free state and

combined as acetate from the rubber of Castilloa elastica. He also found that cerotinic acid formed a constituent of the waxes from various kinds of latex, and that balanophorine is identical with $\beta$-amyrine palmitate.

Further he carried out viscosity determinations of rubber solutions thus providing a means of control during the preparation of plantation rubber. He found papaine to be a good coagulant for latex.

The investigations of O. DE VRIES, working at the Central Rubber Station at Buitenzorg, have above all augmented our knowledge about rubber and the coagulation of latex. He carried out viscosity determinations of rubber solutions and came to the conclusion that these, together with the determinations of the properties after coagulation, would give important indications as to the quality of the latex. DE VRIES also examined the effect produced by ammonia when used as a preservative, upon the properties of latex. According to DE VRIES the enzyme "coagulase" plays an important part in the coagulation of latex.

Recent viscosity determinations of solutions of rubber in acidified benzene, have brought DE VRIES to the view that this is the most trustworthy method for obtaining an insight into the colloidal properties of rubber. Limits of space prevent a further discussion of these researches, but before concluding, attention must be drawn to the investigations of DE VRIES into coagulation phenomena at different degrees of acidity, investigations that entered the domain of pure colloid chemistry. The results of the work accomplished at the Rubber Testing Station, are recorded in the *Archief voor de Rubbercultuur*, a journal appearing now in its 12th. year.

# ON AGRICULTURAL RESEARCH AND EXTENSION WORK IN THE NETHERLAND'S INDIES

by Dr. C. J. J. VAN HALL,
*Formerly Director of the Institute for Plant Diseases, Buitenzorg.*

It may be said of several of the plantation-cultures in the Netherlands Indies that they have reached a high standard. This must be greatly put to the credit of the scientific research.

The planters are convinced that they cannot do without scientific guidance and they have established experiment stations, each of which devotes itself to one, or to a few cultures. The costs are borne by the estates.

The technical divisions of the Department of Agriculture, Commerce and Industry partly devote themselves to the estate crops — and this in close collaboration with private experiment stations — but for a great deal to native agriculture.

The following private experiment stations are at present working in the Netherlands Indies in behalf of the estates: The Experiment Station for the Java Sugar Industry (Pasuruan, with a division in Cheribon); the Experiment Station for Vorstenlanden tobacco (Klaten); the Deli Experiment Station (for the Deli-tobacco culture, Medan); the Experiment Station of the General Association of Rubber Planters at the East Coast of Sumatra, established at Medan (for all cultures, except the tobacco culture in Northern Sumatra and especially for the culture of rubber and of the oilpalm); the Rubber Experiment Station, Buitenzorg; the Tea Experiment Station, Buitenzorg; the Cinchona Experiment Station, Pengalengan; the Experiment Station Malang (Central Experiment Station for the Coffee Culture and also working in behalf of other cultures, especially the rubber culture in the district of Malang); the Besuki Experiment Station (working in behalf of the cultures in Besuki, especially the tobacco culture, the rubber culture and the coffee culture), the Experiment Station Central-Java (in behalf of the cultures in Central-Java, especially the cocoa-, the rubber-, the coffee-, and the kapok culture).

As for the Native Agriculture it receives advice from the Agri-

cultural Instructors of the Department of Agriculture, while research partly rests with, or is supported by the Technical Divisions of the Department of Agriculture.

These Technical Divisions are: the General Experiment Station; the Institute for Plant Diseases; the Agro-Geological Laboratory, the Chemical Laboratory, the Laboratory for Microbiology, the Division for Agronomy, the Division for the Seed-distribution of Annual Plants, the Experiment Garden, the Botanical Laboratory, the Zoological Laboratory, the Division for Agricultural Economy and the Division of Industry.

Of the work of these Divisions only a few details can be mentioned here.

To the Agro-Geological Laboratory we owe a new general method of soil investigation. Several Experiment Stations have adopted this method. A great number of soil specimens and soil types have been investigated and described, so that we are now in a position to make a fairly complete soil map of Java. Important work has also been done in behalf of rational irrigation. The names of MOHR and WHITE must be mentioned in connection with that work.

The Chemical Laboratory in collaboration with the Agricultural Instructors worked out the methodology of the manuring experiments, and gave its assistance in manuring experiments on behalf of the Native Agriculture, and in the interpretation of the results of these experiments. A great number of analyses have been made of food stuffs and of irrigation water for the rice culture.

To the Division of Seed-distribution of Annual Plants native agriculture owes many new plants and varieties, for instance valuable rice varieties and cassava-varieties, the latter of which have also been to the benefit of the cassava estates. Yearly great quantities of plant material of these varieties are distributed throughout the whole archipelago; in 1926 515.133 kg. of cassava-cuttings were sold.

The Experiment Garden is the oldest institution in Java which has been established in behalf of agriculture. As early as 1876 it was established, and one of the first plants, introduced from abroad, was the Liberian coffee, which has played such an important, albeit short-lived part, in the Dutch Indies. The Experiment Garden has served agriculture from the beginning by importing new species and varieties, but especially these last fifteen years it has become of great importance, when the Garden was also used for experimental work. It was in the Experiment Garden that the first figures about production of the oilpalm in the Netherlands Indies were collected, and the attention was drawn to the high yields obtained from the variety grown in the Experiment Garden. Experiments made in this Garden led the way to

a practical method of grafting the Hevea, the Cacao and the Kapok. Experiments with a great number of green fertilizers brought to the fore several valuable kinds: Centrosema plumieri. Calopogonium mucunoides, Vigna hosei a.o. Some important Hevea clones were isolated here. The Rubber Experiment Station, the Tea Experiment Station, the Institution for Plant Diseases and several other institutions make use of the Experiment Garden for their experiments. In these many sided activities, which have developed especially from 1910, the Curator Mr. VAN HELTEN, who is still in function, has played the leading part.

The Institute for Plant Diseases has been working in behalf of a great number of cultures. As some of the most important researches, which were made by this Institute, the following must be mentioned: the investigation of the die back disease of the pepper vines (by RUTGERS) the research of the causes and the treatment and prevention of the brown bast of the Hevea (by RANDS), the selection of varieties of Arachis hypogea, resistant to slime disease (by HARTLEY and SCHWARZ), cure and prevention of cocoa canker [1]) (by VAN HALL and by HARTLEY). the control of the white riceborer [2]) (VAN DER GOOT), means of combating the coconut beetle [3]), of the Brachartona caterpillar [4]) and of the coffee berry borer [5]) (LEEFMANS). Special mention must be made of the new method, adopted by LEEFMANS, in the campaign against the locust plague [6]) of the Talaud islands, by which parasites of the insect are transported from one island (in this case Ambon) to the other. The same method is now used in the fight against the scale [7]) of the coco-nut on the Sangih-islands, the Saleier-islands and the coast of Celebes, by transporting parasites of these pests, from Java to these regions.

The Institute for Plant Diseases managed the transportation of the hymenopterous parasite of the berry borer of the coffee from Uganda to Java (DEN DOOP).

Of the work carried out by the Division of Industry mention must be made of the researches into the retting of coco-nut fibre (KLUYVER) the manufacture of papaine, of cocaine (DE JONG), of sereh-oil and other ethereal oils, the purifying of the balsam of Pinus Merkusii (WELTER).

The private Experiment Stations have been considerably enlarged during these last years.

The industry which was first in asking for scientific assistance and in

[1]) Phytophthora faberi. [2]) Scirpophaga sericea. [3]) Oryctes rhinoceros.
[4]) Brachartona catoxantha. [5]) Stephanoderes hampei. [6]) Sexava nubila.
[7]) Aleurodiscus destructor.

establishing an Experiment Station was the sugar industry. The sugar crisis towards the end of last century, co-inciding with the appearance of the "Sereh disease", made it necessary to place the culture on a firmer footing. In the years 1886 and 1887 three Sugar Experiment Stations were erected at Semarang, Kagok Tegal and Pasuruan. At present the sugar experiment stations have all been amalgamated into one "Experiment Station of the Java Sugar Industry" at Pasuruan.

The researches of this Experiment Station have covered the whole field of cane sugar culture and sugar manufacturing. What has been achieved can somewhat be estimated by comparing the average yield of cane and sugar in following years.

**Production of cane and sugar per H.A.**

| Crop year ..... | 1902 | 1910 | 1925 | 1928 |
|---|---|---|---|---|
| Cane in kg. per hectare... | 80.297 | 97.997 | 108.446 | |
| Sugar „ „ „ „ ... | 8.647 | 10.118 | 12.881 | 14.980 |

How much the fabrication of sugar has been improved can be seen from the following figures:

**Lost on 100 sugar in cane.**

| | |
|---|---|
| 1900 ..... | 9.95 % |
| 1910 ..... | 8.85 % |
| 1920 ..... | 7.50 % |
| 1926 ..... | 5.73 % |

The considerable increase in cane has been particularly due to the new seed-varieties, of which the following have taken a first place: 247 B, 100 P O J, E K 28, D I 52, 2878 P O J. The last mentioned variety was obtained by Prof. JESWIET by crossing different cane species and varieties, among which the wild cane or "glagah" (Saccharum spontaneum). It distinguishes itself through its great power of resistance against diseases (sereh disease, mosaic disease a.o.) and through its great productivity. The manuring experiments have also contributed in a great deal to the increased production. Sulphate of ammonia is the most important manure. Of the important results in cure and prevention of disease may be mentioned the treatment of the pine apple disease (WENT) and the hot water treatment of cuttings as a means of combating the sereh disease (WILBRINK).

With the steady growth in importance of the sugar industry went an extension of the Experiment Station. The yearly budget, which

amounted to ƒ 30.000 at the erection in 1886, now amounts to about ƒ 1.400.000.

The rubber culture belongs to the younger cultures in the Netherlands Indies, but in 1925 and 1926 the value of the product surpassed that of any other agricultural product. Not before 1910 the rubber-tree (Hevea brasiliensis) was planted on a large scale. With this culture the activities of the Experiment Stations and of the Department of Agriculture have especially been developed on the improvement of the tapping system, on selection, on cure and prevention of diseases, the prevention of the soil wash and soil deterioration, and on the preparation. As far as the selection is concerned, since it has become possible, as a result of the researches of VAN HELTEN and of BODDE, to propagate the Hevea by budding, the Experiment Stations and the Experiment Garden of the Department of Agriculture have obtained a great number of valuable clones by means of mother-tree selection. Several of these have proved to be high yielders. It has become a not unimportant part of the work of the Rubber Experiment Stations to supply budwood of such clones. Among the clones, which are of value, the following may be mentioned: A. V. 50, A. V. 36, A. V. 33, A. V. 49, A. V. 157, A. V. 146, A. V. 152, Ct. 88. Of the hybrids hybrid 36 × 35 must be mentioned.

As to the diseases of the Hevea a few years ago the "brown bast" was one of the worst. The cause was found by RANDS of the Institute for Plant diseases: a too drastic tapping. This disease, which caused so much harm about 8 years ago, has now ceased to be of importance. The stripe canker [1]) is also, owing to the investigations of the Experiment Stations, of far less significance than it used to be.

The tobacco culture in Deli has laid other problems before the Deli Experiment Station than the tobacco culture in Java laid before the Experiment Stations of the Vorstenlanden and of Besuki. In Deli a great number of diseases and pests has been studied by various botanists. Of these diseases especially the slime disease [2]), the caterpillars[3]), the tobacco beetle[4]) and recently also the aphis [5]), have been subjects of more thorough investigation. But beside these a great many more diseases and pests were more or less thoroughly studied: bibit-disease [6]), stem canker [7]), mosaic disease, thrips, etc. The study of the slime disease

[1]) Phytophthora faberi.
[2]) Bacillus solanacearum.
[3]) Chloridea assulta, Prodenia litura, Phytometra signata and other kinds.
[4]) Lasioderma serricorne.
[5]) Myzus persicae.
[6]) Phytophthora nicotianae. [7]) Pythium sp.

led to experiments on the subject of crop rotation, which resulted in the application of Mimosa invisa, the cultivation of which, in stead of a fallow for a period of seven years between two tobacco crops, brought a considerable decrease of this disease (DE BUSSY, PALM). The extermination experiments of the caterpillars led to the now generally applied spraying and dusting with lead arsenate. The experiments against the aphis resulted in spraying with an extract of the Derris-root or "akar toeba" (Derris elliptica), used by the Natives as fish poison. Against the tobacco beetle the carbon bisulphide method was found effective (DE BUSSY); especially during the war, when the tobacco often had to be kept in sheds for long periods, it prevented great losses to the tobacco planters.

Questions of selection and manuring formed an important part of the work of the Deli Experiment Station. The line-selection (HONING, JOCHEMS, BROUHIN) supplied the planters with very valuable lines. The greater part of the tobaccofields are no longer planted with populations, but with more or less pure lines, at any rate with offsprings of one mother tree. Thus the offsprings of tree No. 8, (and also those of No. 161 and 180), are now very popular.

In the tobacco of the Vorstenlanden the most prominent disease was the "lanas disease". When the cause [1]) of the disease had been found, farm yard manure of the natives was recognized to be the principal source of infection, and efforts were made to lessen the disease by eliminating this source of infection by disinfecting the manure or by substituting artificial manure (JANSEN, D'ANGREMOND). The "field fungus" (Oidium) also was also a subject of investigation. Application of a sulphur treatment led to important results (D'ANGREMOND). Crop rotation and manuring were here also subjects of research (BEETS). Here also line-selection was applied with success. Very popular are Line Y (LODEWIJKS), Kanari (JENSEN), E K 12 (D'ANGREMOND). In Besuki also prevention and cure of disease and selection of tobacco were important parts of the work of the Experiment Station. The investigations bore upon the treatment of the Phytophthora disease, nematodes, Krekoh disease (GANDRUP, a.o.). Of the most important varieties grown by this Experiment Station (SPRECHER, ARISZ) may be mentioned: Kedu, "Hybrid" (Deli & Kedu), Hat (Deli & Hatano), 272 m 30, 238.

For many years the coffee culture has been a subject of study for the Department of Agriculture and of the Experiment Station Malang. We owe to these institutions the importation of many new species, a.o. of the Liberian Coffee, the Quillou coffee, the Excelsa coffee, the Congensis

[1]) Phytophthora nicotianae.

coffee; the first importation of the Robusta coffee however was managed by a few estates.

Also with this culture the combating of diseases and pests has been a subject of scientific research for many years. In the last few years several research workers have been devoting themselves to the study of the berry borer [1]) and its treatment (LEEFMANS, FRIEDERICHS, BEGEMANN). Thanks to these researches, this pest can now be kept within bounds on most plantations. The importation of an hymenopterous parasite from Uganda was already mentioned. In the last few years the rational application of green manurers and the choice of the most desirable kinds of green manurers have been very important subjects of study, also in the coffee culture.

The cultivation of the oil palm has become of great importance for the East Coast of Sumatra, and subsequently an important subject of investigation for the General Experiment Station of the A.V.R.O.S. Experiments have shown which varieties excel, and the extra-ordinary fact presents itself that at present seeds of these varieties are sent from the Netherlands Indies to Africa, so that the lands of origin of the oil palm are profiting of the scientific research in the Netherlands Indies. The preparation of the oil and the treatment of diseases were important subjects of investigation.

The Tea Experiment Station, of which BERNARD has been the director for twenty years, has devoted itself to the treatment of the diseases and pests of the tea, especially to the control of the Helopeltis (LEEFMANS, MENZEL), to selection (COHEN STUART), tocult ural problems, such as pruning, green fertilizers, picking (GARRITSEN) and curing (NANNINGA, DEUSS).

The Cinchona Experiment Station studied the selection (VAN LEERSUM, KERBOSCH, SPRUIT), the fight of diseases and pests (such as the mites on the seed beds) and green manuring. The work was done in close collaboration with the Government Cinchona Estate. To this collaboration is due an improved method of estimating the cinchona production per tree and per area unit and a more correct appreciation of the clones obtained by selection. Very valuable for the cinchona culture are a.o. the highly productive clones K 63, K 236 K 241, K 35, Letter B.

The institutions, above mentioned, are all working in behalf of agriculture. The scientific work in connection with forestry is done by the Experiment Station for Forestry, established at Buitenzorg, division of the Department of Agriculture. Among the most important researches of this institution may be mentioned: investigations about

[1]) Stephanoderes hampei.

the growth of the Djati tree (Teak) and about the most exact method of estimating Djati trees and Djati woods (BEEKMAN), the macroscopic determination of different kinds of wood (BEEKMAN, DEN BERGER), research on vegetable tanning materials (WIND), on the cultivation of Sandal wood, technical wood investigation, an investigation into practical distinguishing marks for the identification of trees by the bark (THORENAAR).

# ARCHAEOLOGY.

by Dr. N. J. KROM,

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It is during the last part of the eighteenth century that the archaeological remains in the Netherlands Indies, in the first place in Java, are beginning to draw the attention. The only preceding records on the subject are notes, usually brief, on ruins, visited by the officials of the East India Company on their travels in the interior. One of the oldest and most detailed is the description of the temples of Prambanan [1]), written in 1733 by C. A. Lons, Junior Merchant of Semarang. The foundation in 1778 of the "Bataviaasch Genootschap van Kunsten en Wetenschappen" (Batavian Society of Arts and Sciences), the oldest learned Society of the East, points to the penetration into the colonies of the new European thought and ideas. Although the study of antiquities would not take a first place, the members of this association set about to make it one of their subjects of research, and they started making a collection of natural products and curiosities. In the course of years, however, this very association has become the centre and the driving force in the study of archaeology, and out of the said collection the museum of Batavia has grown.

Plans and drawings of remains soon follow; the best known are those which the Governor of Java's North East Coast, N. Engelhard (1801—1808), had made at Prambanan by the engineer officer Cornelius. The same Engelhard diligently collected old works of art which he even had taken out of the temples and brought together into his garden at Semarang. Partly by making use of data already present, partly by engaging a staff of new collaborators, the British Lieutenant-Governor Th. S. Raffles collected between 1811 and 1816 the materials for a summary of all that was known sofar in the "History of Java", published in 1817, thus forming a foundation for subsequent research.

When in 1816 the Dutch Government took over again the colonies,

[1]) Bijdragen tot de Taal-, Land- en Volkenkunde van Ned. Indië, 3 (1855) p. 10—12.

the care for the antiquities, together with many other matters, was entrusted to professor C. G. C. REINWARDT. At his departure he left behind a "Committee for the tracing and preservation of archaeological objects", a committee which, however, failed to assert itself in any way, after having had a great number of antiquities shipped to the Netherlands, among others a part of the collection ENGELHARD, which was going to be the nucleus of the archaeological collection, now in the National Ethnographic Museum at Leyden. To three of these images prof. C. J. C. REUVENS L. L. D., devoted a treatise in 1826 which may be called the first scientific study on a subject of Javanese archaeology [1]).

In 1823 the Government in the Netherlands Indies had, it is true, sent written orders to the Commissioners to the effect that the good custody of the antiquities be taken the greatest care of, but the matter was left at that. In the meanwhile one of the commissioners, C. L. HARTMANN, had had several antiquities in his Residency Kedu excavated with great diligence. For the rest the interest came especially from the side of private people, the painter H. N. SIEBURGH, who painted a number of antiquities, and the representative of the Bible Society, Dr. C. J. VAN DER VLIS, who described some. The plan of these two men to produce in collaboration a great work on Javanese antiquities and art was frustrated by their death in 1842.

In 1840 the exportation of the antiquities was prohibited, and two years later the responsibility of the local authorities for the archaeological remains was once more explicitly laid down by the Government. These antiquities had to be protected, and casu quo saved and collected; but in general the Government strongly disapproved of the removal of the antiquities from the places where they were found, as long as measures could be taken to keep them there. Removal implies a slow demolition of the old buildings and such a demolition ought to be the more prevented in proportion as those buildings supply new and unstudied contributions to the history of the old Javanese civilization. In later years this praiseworthy standpoint of 1842 was unfortunately but all too often departed from.

The appointment of Dr. W. R. VAN HOËVELL as Chairman of the Batavian Society (1845—1848) brought with it, firstly the initiative to the compilation of a Corpus Inscriptionum (not continued because of the death of the appointed compiler), and secondly a good Catalogue of the archaeological collection of the Society, written by Dr. R. H. TH. FRIEDERICH and published in 1847—1850 [2]). The collection at

[1]) Gedenkschr. Derde Klasse Kon. Inst. v. Wetensch. 3 (1826), p. 1—222.

[2]) Verhandelingen Bataviaasch Genootschap, 21 and 23.

Leyden had already been described by Dr. C. LEEMANS in 1842. In these years scientists had great expectations of the application of the new Daguerre-procedure to obtain reproductions of the antiquities, and especially of the best known among them, the Barabudur. The experiment failed, but the idea would be realized through another channel As a first Government-instruction for an archaeological survey the draughtsman of the Royal Engineers, F. C. WILSEN, was put to work from 1849 until 1853 to make detailed drawings of the Barabudur with all its reliefs. Explanatory notes would accompany it.

The Rev. J. F. G. BRUMUND who had written excellent descriptions of a number of temples of Central and East Java in his book Indiana, published in 1853—1854, was obviously *the* man to supply those notes. Through all kinds of misunderstandings, however, nothing came of it, and BRUMUND's work was put into the hands of LEEMANS, director of the Leyden Museum, in order to use it with other material in a Barabudur-text. In consequence of a prolonged bungling with reference to the reproduction of the drawings the book did not appear until 1873.

Meanwhile BRUMUND had found other work in the sphere of archaeology. Pressure from the Netherlands caused the Government to decide in 1862 to have a „description of the Hindu-antiquities in Java" written, to wit, a critical treatise on the literature and a description of the grouping, the architecture and the sculpture of the monuments with their meaning and religious character. This order of wide purport was entered upon by BRUMUND with great enthusiasm, but in the mids tof his work he was carried off in 1863. What had been finished was published in 1868 under the title of „Contributions towards the knowledge of Hinduism in Java" [1]); these treatises bear witness to a great power of observation, and considerable insight into the history of art.

The opportunity to continue BRUMUND's work was given to the above mentioned Dr. FRIEDERICH; he did not, however, get beyond writing a couple of scientific accounts of travel. Among his assistants was a soldier, N. W. HOEPERMANS, whose reports submitted to his chief were kept and published in 1913 [2]); although written in a clumsy and matter-of-fact style, they contain a great number of important data with reference to the condition and to the history of the antiquities. A contemporary summary of the East-Javanese antiquities by J. HAGEMAN is of far less importance

The photographer J. VAN KINSBERGEN was to have collaborated in BRUMUND's survey, but after the latter's death he began working independently. Headstrong artist that he was, he did not produce a

[1]) Verhand. 33. [2]) Report of the Archaeological Service for 1913.

photographic survey of the whole of the antiquities, but an unsystematic collection of 333 splendid photographs, published by the Government in 1872 in a portfolio called "Antiquities of Java". Later it was followed by a survey of the Barabudur on a smaller scale.

VAN KINSBERGEN'S activities resulted in a first endeavour from the side of the Government towards archaeological investigation of the soil. For the making of the photographs repeated cleanings and excavation of the neglected monuments had been necessary, and especially on the table-land of Diëng, where the oldest products of Hindu-Javanese art are to be found, a great many things appeared to be still hidden in the soil. This led to further investigations also after VAN KINSBERGEN'S departure. The supervision was entrusted to an engineer of the public works department living elsewhere, who only came to have a look when his other work permitted him to do so, and for the rest allowed the local natives to take their own line. With intervals this investigation lasted from 1864 until 1878; it did more harm than good, for the conductor was of course no expert archaeologist, and the excavated foundations fell a prey to the neighbouring inhabitants. Justifiable criticism has consequently not been wanting. An attempt made at the same time to ensure the preservation of the principal monuments of Java by a fixed sum on the budget was successful at first, but did not lead to permanent results.

In 1873 LEEMANS'S monograph of the Barabudur appeared. Thanks to BRUMUND'S contributions especially, all that was known with reference to the Javanese antiquities at that time was brought together in this work. A few years later J. FERGUSSON tried in his "History of Indian and Eastern Architecture" (1876) to assign to the Hindu-Javanese art its place in the great complex of the Indian art in general. In 1878 prof. P. J. VETH published an accurate, and of its kind excellent compilation of all the available material in the chapters devoted to the antiquities of his great work "Java" [1]). In these years Dr. A. B. COHEN STUART also produced his Kawi-records (1875), as a first edition on a larger scale of inscriptions with facsimile, after preceding scattered publications. This edition was published by the Batavian Society as well as that of K. F. HOLLE'S "Table of old and new Indian Alphabets" in 1882. In the Netherlands Prof. H. KERN took in hand the epigraphic research.

As must be clear from these pages interest had been nearly exclusively centred in and around Java. People knew a few things about the

[1]) Second, revised, edition in 1896.

antiquities elsewhere, for instance in Sumatra (Djambi, the Padang Highlands, Tapanuli), and in Borneo, but only short notes or descriptions had been published. Neither is there any question of praehistoric archaeology; only the stone axes, which had drawn the attention of RUMPHIUS as early as the eighteenth century, received some attention and an attempt was being made to group them to some extent.

After 1880 a period of great activities began with reference to the antiquities from the side of private people, supported by the Batavian Society, and soon after also from the side of the Government. In 1887 a new Catalogue of the collection of antiquities of the Society was drawn up by W. P. GROENEVELDT; it was clear, clever and cautious. The epigraphic part was written by Dr. J. L. A. BRANDES, who, as linguistic civil officer, had recently been charged with the study of the inscriptions.

The geologist Dr. R. D. M. VERBEEK, who was then exploring Java, was invited to collect at the same time the data for an archaeologic map; he did much more, however, and in 1891 he published together with the map his "Oudheden van Java" (Antiquities of Java) [1], to wit, a complete inventory of the antiquities with short descriptions and with all the literature. Java was one of the first countries of the world where a scientific inventory of that type came into existence; in making the new inventories published during the last few years it was not necessary to do anything but to continue on the foundation laid by VERBEEK.

In 1885 an Archaeological Society was started at Jogjakarta in Central Java by private initiative under the guidance of the engineer J. W. IJZERMAN. It devoted its attention more in particular to the antiquities of Prambanan; these were examined and partly excavated. The results were recorded by IJZERMAN in his book „Beschrijving der oudheden nabij de grens der residenties Soerakarta en Djogdjakarta" (Description of the antiquities near the frontier of the Residencies Surakarta and Jogjakarta). It was published in 1891 through the medium of the Batavian Society and it is a standard-work which is still being consulted with success. Two years later the same IJZERMAN wrote a first detailed description of a Sumatran antiquity, the one at Muara Takus at the Upper Kampar [2]. Meanwhile Dr. J. GRONEMAN had been called to the chair of the Jogjakarta Society, while further excavations of Prambanan were also entrusted to his care; unfortunately he had the newly gained fragments mixed together in a very injudicious

[1] Verhand. Bat. Gen. 41.
[2] Tijdschrift Bat. Gen. 35 (1893), p. 48—74.

fashion, and although much was preserved by him in the museum at Jogjakarta, which he founded, a great many things thus put together would have been better left at their original places His book, however, "Tjandi Parambanan op Midden Java na de ontgraving" (Chandi Prambanan in Central Java after the excavation), which was accompanied by many phototypes, has been instrumental in rousing interest for the antiquities in larger circles. It was published in 1893 by the "Koninklijk Instituut voor de Taal-, Land- en Volkenkunde van Nederlandsch-Indië" (Royal Institute for the Philology, Geography and Ethnology of the Dutch Indies), the body to which the same task is entrusted in the Netherlands which the Batavian Society performs in the Dutch Indies.

If an attempt made in 1887 to come to a regular archaeological supervision was frustrated by the expenses entailed, the Government showed in another direction to become alive to its responsibilities with reference to the old monuments When the temple Mĕndut (in the neighbourhood of the Barabudur) was reported to be in a state of dilapidation, and the magnificent images in it were threatened with danger, it was decided on principle to go over to restoration, which was begun in 1897 after prolonged preparations The condition of the monument was beforehand recorded in KERSJES and DEN HAMER's „De Tjandi Mendoet voor de restauratie" (Chandi Mĕndut before the restoration). During the course of activities the Government decided that restoration was not to be carried beyond measures for the prevention of further dilapidation.

But also the Barabudur itself began to show signs of threatening decay. In order to be advised as to what ought to be done to prevent ruin the Government set up the so-called Barabudur Committee in 1900 with Dr. BRANDES as chairman; the local investigations were entrusted to the engineer-officer TH. VAN ERP, member of the committee, who lived near the spot. The same officer also distinguished himself in the following year by partial repairs at Prambanan. But the restoration of the important sanctuary Panataran, which was deemed necessary, was even as late as 1901 put into the hands of a Javanese Public Works surveyor with two masons, who bungled there to their hearts' content.

The Exhibition at Paris in 1900 proved to be of particular importance to the further history of Javanese archaeology. The preparation of its Indian section called two books into existence: C. M. PLEYTE's „Die Buddha-Legende in den Skulpturen des Tempels von Bôrô-Budur" (1901) in which the author was able to explain one of the relief-series from the contents of the text represented, and E. A. VON SAHER's "De versierende kunsten in Nederlandsch Oost-Indië" (1900) (The Decor-

ative Arts in the Dutch East Indies), in which reproductions were published and explained of the casts of Javanese monuments originally made for the Exhibition. The latter work has in its turn given the impetus to the aesthetical observations of G. P. Rouffaer, who clearly elucidated the value of the classical art of Java [1]). The exhibit itself drew the attention very much indeed and was an eyeopener to many a one with reference to the importance of these monuments; thanks to IJzerman's perseverance this favourable opportunity was put to a good use and a permanent, official Archaeological Committee for the antiquities (at first only those of Java) came into being. It consisted of three members; Dr. Brandes was again its Chairman.

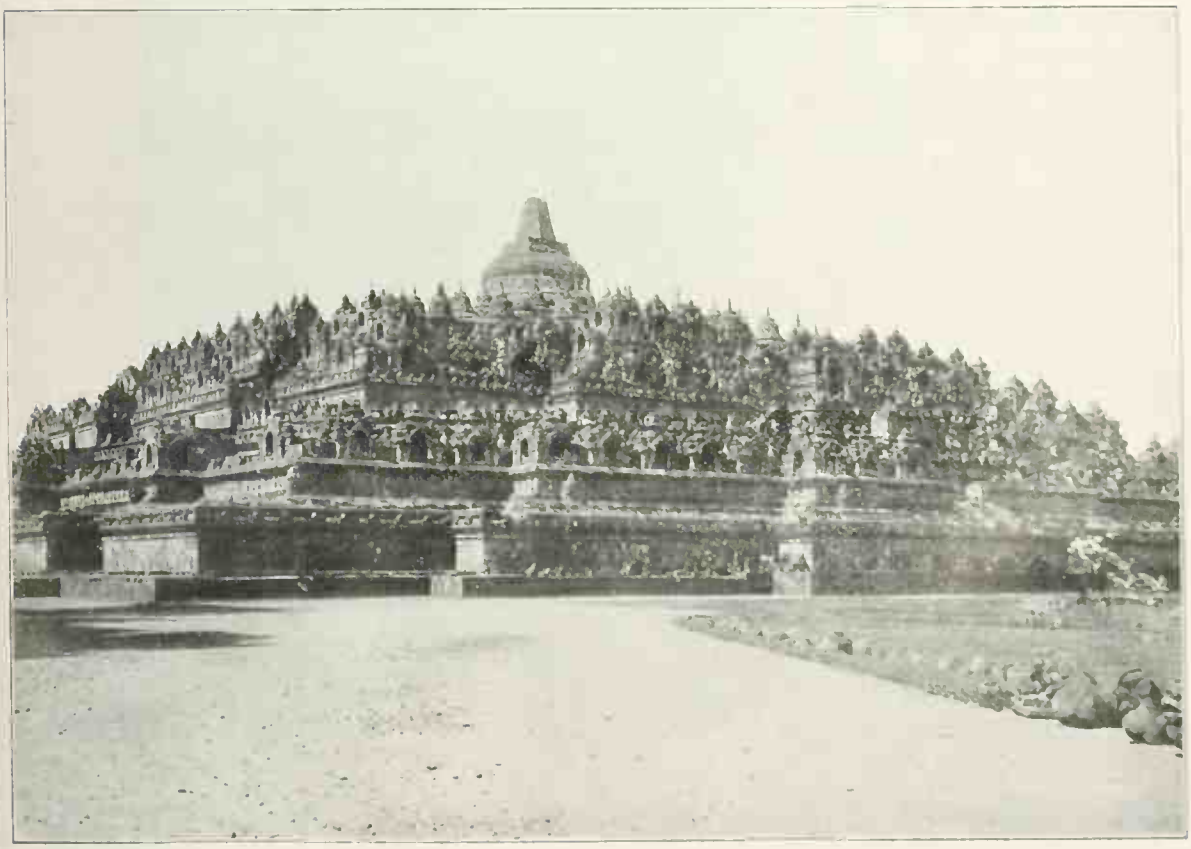
The Committee's task was singularly restricted. It was defined as to comprise the writing of archaeological and architectonic descriptions of the antiquities, the making of drawings and photo's of these, and the suggesting of means to guard the monuments from decay. So not only the carrying out of measures, eventually deemed necessary, was left out of it, but also the whole of the archaeological research beyond the bounds of the description of monuments was out of the question.

It is Brandes's great merit that he has laid to heart in the widest sense all that concerned the antiquities, notwithstanding the above mentioned inadequate wording. During his office, which lasted only four years (1901—1905), he examined numerous sanctuaries, carried out restorations (Pawon) or continued them (Mendut), spread light in a stream of publications about the most widely divergent archaeological subjects, wrote a monography on the remarkable temple of Djago (1904), collected the material for another, published after his death under the name of "Tjandi Singasari en de Wolkentooneelen van Panataran" (1909); but above all did he succeed in suggesting the great lines along which archaeological and art historical research would have to be carried on, and in formulating the problems the systematic solution of which would give the indispensable insight. The way in which he himself began to work at that solution with untiring energy, and an admirable intuition for what would prove essential and what accidental can be best studied from the official three-monthly reports, originally not meant for publication, but later published just as they were, through the kind offices of the Batavian Society. The complete list of Brandes's writings are to be found in the Commemoration by G. P. Rouffaer, which was printed as part of the above mentioned work on Chandi Singasari.

As far as his restorations were concerned Brandes's opinion was that one had a right to repair a ruin into its old condition, if needs be

[1]) De Gids 1901, II, p. 225—252.

Barabudur before the restoration.



Barabudur restored.

by using new building stones, as soon as there were enough data at hand concerning that former condition. It may not be denied here that mistakes were made that way, which illustrated only too clearly the danger of such reconstructions. A second drawback of BRANDES's way of working was that he planned and decided everything by himself, while his fellow-committee members, who were neither consulted, nor ever informed of the plans had to be merely the executors of the chairman's instructions, the one with reference to technical matters, the other for the making of inventories and bibliographies The consequence was that BRANDES's work came to a sudden stop at his death in 1905, and that a period of decline began.

Only in one respect there could be a question of continuation. The Barabudur Committee, which had not been amalgamated with the Archaeological Committee, but which had carried on activities on its own, had suggested measures towards the preservation of this monument, and the one and only remaining member of the committee, TH. VAN ERP, was *the* man to carry out these activities. VAN ERP's great Barabudur restoration took place between 1907 and 1911; the measures originally conceived for this restoration were, when it proved to be desirable, extended into more drastic reconstructions which aimed at rendering the monument something of its original character by re-establishing the silhouette-effect and the heavy horizontal lines. However by no means all the restorations, for which the necessary data had been collected, were carried out (which in the case of this very regular style of architecture would have meant reconstruction of the whole monument), but VAN ERP limited himself to what was absolutely essential to his purpose, for the rest taking great care to leave the ruin such as it was. So Barabudur has indeed remained a ruin, but one highly suggestive of the effect the planner had wished to aim at. The Barabudur restoration is an exemplary piece of work A photographic survey taken at the same time was to be used for a new monography of this sanctuary, which was to be written by Government order. The archaeological description by the author of these pages was published in 1920 (English translation in 1927); the architectonic description by VAN ERP is still in course of preparation.

The cessation of the work of the Archaeological Committee fortunately did not imply the cessation of Javanese archaeology in general The publication of BRANDES's posthumous works, made possible by means of important amplifications by G. P. ROUFFAER, has already been mentioned. Prof. KERN resumed his epigraphic work, suspended while BRANDES was in office, and continued it until his death in 1917. On the ground of new data VAN ERP wrote a summary on Central Javanese

art, forming part of "The twentieth century impressions of Netherlands India" (1909). In the same year A. Foucher threw a new and clearer light on the signification of several Buddhistic sanctuaries [1]), and Dr. H. H. Juynboll published a new Catalogue of the Leyden museum [2]), thereby following the method which Groeneveldt had applied for Batavia. The new edition of Fergusson's History (see above p. 279), however, was disappointing on account of its untrustworthiness and its incompleteness. J. F. Scheltema's book, „Monumental Java" (1912), which was published a little later, also contains inaccuracies, but by means of its illustrations and vivid descriptions it suggests the impression made by the Javanese monuments on the artistically sensitive layman.

In 1910 the Archaeological Committee obtained a new chairman in the person of the writer of these pages, and a new organization could be introduced. Now that the drawbacks of a committee had appeared to be conclusive the organisation took the form of a permanent branch of Government service, the Archaeological Service, which was instituted in 1913, and which was vested with power throughout the whole of the Netherlands Indies To that Department has been entrusted "the making of inventories and, in concert with the provincial authorities, the care of the antiquities in the Netherlands Indies, whether they be of Hindu, Mohammedan, Chinese or Dutch origin, the planning and the carrying out of measures to guard these antiquities against further decay, the taking of photo's and the making of surveys, and further in general the archaeological research in the widest sense, also in the sphere of epigraphy". From this it is evident that no thought had been given to the native antiquities proper, in particular the praehistorica. The research into these has only been taken in hand during these last few years, in fact since 1924.

Here we shall give a somewhat fuller account concerning the activities of the Archaeological Service, of which Dr. F. D. K. Bosch has been the head since 1916. First a few other facts may be mentioned. In 1919 a chair of the archaeology and ancient history of the Dutch Indies was instituted at the State University at Leyden. These subjects were made to form a part of the training of different categories of civil servants: of the academic theses published in connection therewith we mention W. F. Stutterheim's "Rama-Legenden und Rama-Reliefs in Indonesien", and P. V. van Stein—Callenfels's 'De Sudamala in de Hindu-Javaansche kunst" (both 1924) [3]). In his book "Java", published in 1920, Dr

[1]) Bulletin de l'Ecole française d'Extrême-Orient 9, p. 1—50.
[2]) Vol. 9 of the General Catalogue; also published in German.
[3]) Published in Verhand. Bat. Gen. 66 (1925).

K. WITH devotes special attention to the philosophic principles of Hindu art, and the way in which in Java the ensuing problems of architecture and sculpture were solved; he also traces in how far the Indonesian element happened to be instrumental towards that solution. In the same year 1920 the writer of this article endeavoured to give in his "Inleiding tot de Hindoe-Javaansche kunst" (Introduction to Hindu-Javanese art) a survey and critical appreciation as complete as possible of the material on hand. A second edition appeared in 1923 [1]). For the benefit of English readers may finally be mentioned the study of Prof. J. PH. VOGEL "The relation between the art of India and Java", (India Society, 1925) and the chapters devoted to Indonesia of COOMARASWAMY's "History of Indian and Indonesian art" (1927).

Among the kinds of antiquities mentioned in the instruction of the Archaeological Service the Chinese are the least numerous; although the Chinese have come to the Archipelago ever since the first centuries of our era, and partly have settled there permanently, they have not achieved any important monuments. Except for a few images, preserved in Chinese temples, it is especially in the case of the old historically important Chinese tombs that the Service intervenes if necessary.

The Mohammedan antiquities too are of far less importance than one would have expected in the Archipelago, which partly is predominantly Islamitic. Even in the time of their greatest political prosperity the Mohammedan governments did not erect buildings which were in keeping with that prosperity, and in proportion as their position weakened the desire to built also decreased. Thus only the remains of old royal residences show something remarkable here and there, and so do a few mosque-complexes, generally lacking in originality and betraying partly Hindu-Javanese, partly also Dutch influence. Finally there are still a few old burial-places of which especially those in Northern-Sumatra have proved of importance on the ground of historical data supplied by the tomb stones.

Instead of Dutch antiquities one really ought to say European antiquities, for although by far the greater majority of the remains can be ascribed to the Dutch East India Company, yet the Portuguese, and in a less degree the Spaniards and the English have left traces of their presence too. Remains of Portuguese forts are to be found especially in the Molucca's and the minor Sunda Islands, Spanish ones also in the Molucca's, English ones in Sumatra, Dutch ones throughout the

[1]) The first chapter contains a detailed history of archaeological research in the Dutch Indies.

whole of the Archipelago. Through lack of means and staff the Service has not been able to devote as much attention to this category of antiquities as it would have liked to do.

As complete a photographic survey of the remains of old Batavia as it was possible to make has been used to illustrate Dr. F. DE HAAN's work, "Oud Batavia", written in 1922; beautiful specimens of Dutch architecture are, for instance, to be seen in the Town Hall, in the Government Record Office, and in the Portuguese „Buitenkerk", restored under supervision of the Service. In 1921 V. I. VAN DE WALL made an inquiry on the spot as to what was left in the Molucca's in the matter of antiquities. The result was that much more was found than had been conjectured, but that the greater part of these remains were in a sad condition of dilapidation [1]). Since then a few of the most urgent measures for their preservation have been taken in a modest way; for the rest the Department sees to it that no old buildings are broken down or spoilt.

"Prehistoric" is a relative idea in the Archipelago, which expresses a state of culture rather than a chronological indication; for even now there are regions (New Guinea), where the population lives in a stone age. Yet there are also remains which may be called prehistoric in the fullest sense, and the researches, since 1924 entered upon by Dr. P. V. VAN STEIN CALLENFELS, Inspector of the Department, have been concerned with these. Quite independently the Austrian scholar, Dr. R. VAN HEINE GELDERN, came to about similar conclusions in a study of stone axes, etc. [2])

Earlier the large megalithic monuments in the East of Java had drawn the attention, monuments which correspond to similar remains in the more eastwardly situated minor Sunda Islands, which have escaped Hindu influence, and also the sanctuaries with terraces and ancestor images, which are especially found in Western Java. These were made by the population, which was there before the arrival of the Hindu's, but they remained in use up to far into the time of the Hindu rule.

To the kindness of Dr. VAN STEIN CALLENFELS we owe the following outline of the state and prospects of his researches. They correspond to those in French Further India, made by MANSUY, later assisted by Miss COLANI, and by PATTE (see Publications of the „Service géologique") and to

[1]) Oudheidkundig Verslag 1921 p. 105—140. In 1928 the same author published „De Nederlandsche oudheden in de Molukken" (The Dutch antiquities in the Molucca's).

[2]) See Festschrift Schmidt (1928).

the excavations in the Malay Peninsula by EVANS and WRIGHT (see Journ. F. M. S. Museums). As regards the Archipelago, activities before 1924 were especially focussed on literature about neolithic tools brought together in the different museums. Apart from the investigations which led to the finding of the Pithecanthropus and the Wadjak-skulls, prehistoric investigations in the field had been limited to the exploration of the caves at Lamontjong (Celebes) by the Cousins SARASIN [1]), who there discovered a microlithic culture, ascribed by them to the ancestors of the present inhabitants, the To'ala's, whom they consider to belong to a big Vedda race, the primitive race of Southern Asia. The fragments and tools of volcanic glass, mentioned and discussed by one of the SARASIN's, and held to originate from a fairly early age, have probably been dated too early (a similar discovery by Dr. ZWIERZYCKI perhaps points to a late neolithic period); the Sumatran tools dealt with in the same article, and identified as to belong to the transition period from hewn axes into polished ones, are in reality nothing but semi-manufactured articles of a late neolithic age, provisionally and roughly beaten in order to be polished later on.

In 1924 the first really palaeolithic tool was found at the East-Coast of Sumatra in the neigbourhood of Si Bolangit by the missionary NEUMANN; it was a hand axe of Chelléo-Moustérien type. An investigation in that year by the Service brought to light that the position of the object was secondary, sothat no further results were obtained. Meanwhile the appearance of large hills, consisting of shells, in the low coastal belt of Atjeh and Eastern Sumatra had drawn the attention in 1919 and 1920. A first superficial investigation by the Department showed already that these were identical with the garbage heaps, in pre history known as "kjökkenmöddinger" A similar heap of shells on the estate Saentis near Medan was systematically dug down in 1925—1927. As a provisional result — definitive publication is yet to take place — can be stated that the hand axe of Chelléo-Moustérien type appeared to belong to the phase of culture of the kjökkenmöddinger at the East-Coast. Earthenware was not found, not even a potsherd, only a few very modern pieces on the top which have come from the present population. In the top layers were some iron weapons of the shape the Bataks use now, but somewhat old fashioned. In the hill itself the Mesolithicum and the Iron Age thus immediately succeed each other As elsewhere at the East Coast, more towards the interior, a copper axe, and at some other place a polished axe of Dravidian type (see below, type 1) were found, it is evident that neither the Neolithicum nor the Copperbronze

[1]) Materialien zur Naturgeschichte der Insel Celebes V, 1 (1905).

period were unknown in Northern Sumatra. Whether the shell-hills have been taken into use again after a long period of rest, or whether a very primitive population, which did not die out until the Iron Age, used to live during a great number of years in the swampforest at the coast, further researches must show. The shell-hill of Saentis, which is now situated from 7 to 8 km. from the coast, appeared to have stood on an old beach; there are, however, no data known concerning a rise of the East-coast of Sumatra and accretion of land on the spot, so that no conclusions can be drawn with reference to dates.

During these excavations it became evident that on many estates of Sumatra's East-coast typical hand-axes were found of the same type as those of the shell-hills; they were made by knocking off a fragment of a river-boulder, and by shaping it on one side, while the other side was left to keep the original surface of the boulder. This typically shaped axe (among others also known in Africa) clearly pointed in Southern East Asia to the mesolithic or protoneolithic phase of culture of the Bacsonien, discovered by MANSUY and his fellow-workers in the caves of limestone mountains in Northern Tonkin. It was obvious that inquiries should be made as to whether this phase also occurred in the Malay Peninsula. In order to ascertain this, and to demonstrate at the same time the methods of excavation applied in the Dutch Indies, with the purpose of arriving at uniform methods, an excavation took place in 1926—'27 in collaboration with Mr. I. H. N. EVANS between Taiping and Kuala Kangsar, which proved [1]) that in the peninsula the same phase of culture once prevailed as in Northern Tonkin, even as regards the protoneolithic axes of the Bacsonien, which show the first traces of polishing; that pottery was made also, but not until the second half of this period; that consequently the Bacsonien must be divided into two periods, an older age when there was no question yet of pottery or protoneolithic objects, and which also existed along Sumatra's East-coast, and a later one with protoneolithic objects and finally even with pottery, which has not yet been found in Sumatra.

In the meanwhile a cave had been discovered in the district of Ponorogo in Java by engineer VAN ES, geologist in the Department of Mines; this grotto showed remains of a phase of culture, which in many respects strongly reminded of the Azilien. Chiefly chisels wese found, made of bone, but also piercers and fish hooks; and human skeletons, which had been buried there, were dug up too. Stone objects and pottery were not found, so that this phase probably also belongs to the Mesolithicum. This grotto and an other, which is situated in the district of

[1]) Oudh. Versl. 1926 p. 181—193.

Bodjonĕgoro, were during the writing of this account systematically examined by the Archaeological Service and engineer VAN ES.

In order to obtain a survey of the different neolithic tools in the Archipelago, and the distribution of the types, the districts are being systematically searched one by one since 1924 for the purpose of collecting these objects. Taking the axes and adzes as basic-types it has been possible to define for the present four culture-phases, to wit·

1. The axes have a round, oval or lens-shaped section (the so-called Dravidian-type, still in use in some parts of New Guinea; found in Sumatra and Celebes as pre-historic tools.)
2. At the back the axes are no longer pointed as so many axes belonging to group 1. Some flats are still more or less spherical, others are polished to a level, often in such a way that different narrow flats topping each other cornerwise, are formed. The objects are of a clumsy shape. This type probably is not derived from 1.
3. All sides are polished flat, but the section is square and the shape still clumsy.
4. To this group belong the exceedingly beautifully polished axes of the late-neolithicum of Southern Sumatra, Java and Bali. Axes and adzes are in section in general much more broad than high. To this group also belong the pointed axes which are typical of the Malay culture-phase of the late-neolithicum, as contrasted with the dented axes of the Mon-Khmer phase of the same age.

There are not sufficient data known yet to allow the fixing of a relative or absolute chronology of the stone-age in Southern-East-Asia. But the splitting up into a Malay and a Mon-Khmer province during, or at the beginning of phase 4, can be fixed at 2000 B.C at the very latest; and that time ought to be accepted as the epoch in which the tribes, which have been settled in the Archipelago the shortest time (the Malay and the inhabitants of Java), must have left the continent. At the same time it becomes evident that the emigration of the ancestors of Austro-Asiatics and Austronesians (at least, if this was an emigration and not an extension of culture), assumed by SCHMIDT, cannot have taken place over the Hindukush and through the Punjab, but that it came from Further India to the plain of the Ganges.

As prehistoric research in the Archipelago is drawing much attention just now, it was desirable to give some details about its aims and methods. Now we arrive at the antiquities of Hindu origin, or, more correctly, the Hindu-Javanese antiquities to which the Service devotes most of its attention and energy.

In the beginning of our era the populations of Sumatra, Java,

Bali and parts of Borneo came into touch with the Hindu civilization; introduced by merchants it quietly but increasingly spread to the extent that by degrees large parts of the above mentioned islands came under Hindu influence, viz. a mixed Hindu-Indonesian culture came into existence, which for social and public ends made as great a use as was possible of usages and customs borrowed from British India, while intimately and privately holding on to all kinds of native elements.

In the centra of civilization royal rule, state government, jurisdiction, religion — the Çiwa-worship as well as Buddhism had been introduced — were organized on Hindu lines — but with the distance from those centra the original customs and conceptions of the country gained in strength. The oldest and certain traces of the existence of such realms date from about the fourth century, but, perhaps as a consequence of some new immigration, we can only form ourselves a clear conception of their nature from the seventh century onwards. at least as far as Java is concerned.

The centre of the Hindu-Javanese culture was then established in Central Java, particularly in the residencies Kedu, Jogjakarta and Surakarta; the archaeological remains, nearly exclusively sanctuaries and idols, date from the eighth and ninth century. The oldest phase is among others represented on the already mentioned Diëng-plateau where a great number of little, simple temples and other buildings were erected. Towards the middle of the eighth century Java came into close touch with the Sumatran empire of Çrîwijaya, which was then very prosperous; a great enrichment and more daring in the architecture of the temples was the immediate result. This was the age of the great monuments of the Mahâyânistic Buddhism, particularly of the Barabudur. Also when the relations with Sumatra were broken, the same course was persued, as witnessed by the Çiwaïtic complex of Lara-Djonggrang at Prambanan, which was built towards the end of the ninth century. The characteristic of this whole period is a close observation of and a holding on to British-Indian traditions.

In consequence of circumstances, unknown to us, the culture centre was in the beginning of the tenth century transferred to Eastern Java in the residencies of Surabaja, Kediri and Pasuruan. Of the centuries immediately following but few remains have been saved; only from the thirteenth century onwards there is sufficient material at our service. It appears, that then this East-Javanese art had assumed another character, because the native element began to show more clearly. Art and culture underwent a change by which it became more distinctly Javanese. To this art the name is attached of the kingdom of Singasari of the thirteenth century, and more particularly that of Majapahit,

which extended its power throughout the whole Archipelago, and which flourished in the fourteenth century. Thereupon followed a time of slow decline, showing but a slight revival towards the end of this period, when the Çiwa-worship, which was ever more retreating towards the mountains before the approach of the Islam, came into touch with the Indonesian terraced sanctuaries, which still existed there. The principal monument of the age of Singasari is the temple of Djago, to which BRANDES devoted his first monography; of the flourishing period of Majapahit the complex of Panataran are the most important remains. In the beginning of the sixteenth century the Islam put an end to everything, although a vain attempt was made to adapt the old art of building to the new needs.

While in Borneo only a few inscriptions and detached images have remained, we possess in Sumatra and in Bali a number of ruins of temples, although far fewer than in Java. The Sumatran ones can be distinguished into those which are a product of the Hindu-Sumatran culture proceeding from direct colonization out of British India, and those come into existence through Hindu-Javanese influences, as are to be observed ever since the tenth century. The first category can be found at the already mentioned Muara Takus and in Tapanuli, the second kind in Djambi and the Padang-Highlands, but not always a line can be drawn, as also during the Javanese period the relations between Southern British India and the East-coast of Sumatra remained firmly established. Worth mentioning are in this island a group of altogether non-Hindu antiquities in the Highlands of Palembang, where a number of images of people with thick lips and protruding jaws and with clothes, which are neither Hindu nor native, constitute an ethnological and archaeological enigma. [1]) The island of Bali underwent very early the Hindu influence; the Hindu-Balinese art has been able to maintain its own character notwithstanding the strong political and cultural influence exerted by Java. There are few old monuments left.

This short outline may help to understand some of the problems to the solution of which the Archaeological Service tries to collaborate. Acting according to the instruction to „make archaeological researches in the widest sense" the Service has always aimed, not only and exclusively at finding and conserving material, but also at maintaining a lively interest in all problems connected with archaeology. In this brief article we cannot enter more fully into the epigraphic activities and the way in which the data supplied by the documents are used towards the reconstruction of Java's ancient history — a beginning has now been made with the

[1]) See Westenenk, Oudh. Versl. 1922, p. 31—37.

publication of Balinese inscriptions too [1]) — but also with reference to more purely archaeological problems a short indication must suffice.

There is in the first place the question of the origin of the Hindu-Javanese art. No doubt its general character is Hindu but yet it shows its own particular features; it has not been possible to trace with certainty anywhere in British India a prototype or equivalent of it and moreover it is possible that in Java itself this art had been practised already a long time before the oldest monuments, which have been preserved. In 1919 Dr. Bosch tried to explain its peculiar character by the hypothesis [2]) that Indonesian architects carried out the rules of the Hindu tradition, which had come down to them chiefly in writing: hence the somewhat clumsy architecture of the oldest buildings alongside their excellent ornamentation, a thing practised of old by the Indonesian people Absolutely opposed is the opinion [3]) which deems the native workers unable to create anything like these monuments, and which ascribes them to the genius of pure Hindu's; the lack of objects for comparison in the home-land is in that case explained by a scarcity of art-historic material of the times and in the regions which would come into consideration for this purpose. Between these two extremes is the theory which looks upon the oldest Hindu-Javanese art as a product of the mixed Hindu-Javanese society, and which supposes the artists to have been neither Hindu, nor Indonesian, but Hindu-Javanese.

A second question is concerned with the relation between Central-Javanese and East-Javanese art, a problem the solution of which is hampered by the absence of material out of the intermediate centuries. Did East-Javanese art naturally grow out of the Central-Javanese one, and should we be able to state a gradual transition, if not so many data had disappeared? Or is there more reason to suppose that the Hindu art of Central Java, and the nationalized art of East Java are essentially different, and that an art of this more Indonesian character may have existed in East Java, at the same time when the Central-Javanese art was practised, which has come down to us? Both theories have been defended. Early East-Javanese buildings are pointed at, which correspond to Central-Javanese architecture as far as their ornamentation is concerned, e g. Chandi's Badut and Bĕsuki near Malang; but on the other hand attention has been called to the fact that a monument as for instance the burial-and-bathing place of Djalatunda in Surabaja, while built only three

[1]) Epigraphia Balica I, Verh. Bat. Gen. 66 (1926).

[2]) Hand. Eerste Congres Taal-, Land- en Volkenk. v. Java (1921), p. 93—169.

[3]) For instance Wolff Schoemaker, Aesthetiek en oorsprong der Hindoe-kunst op Java (1924).

quarters of a century after the last Central Javanese temples, already shows a formation too essentially East Javanese in character to allow of the hypothesis that it should have been „derived" from the former.

In view of the close cultural connection between Java and Sumatra during a part of the eighth and ninth century the question arises whether it would be possible to trace Sumatran influences in the Javanese art; also whether Javanese characteristics might be found in the specifically Balinese art in Bali; further it is to be wondered at in how far the development of art and culture, such as has been uninterruptedly going on in Bali up to the present day, contains data for Javanese conditions of a couple of centuries ago. The answer to all these and similar problems, if ever it will be found, turns on the archaeological material, taken in the widest sense, and the Service is well aware of that fact.

But now a few details about the actual supervision of the antiquities, and the organization of the Service. The general management rests with the head-office at Batavia (still modestly housed in the „Museumlaan") where also all study material consisting of photo's, drawings, reports, etc. are collected and studied; here publications are written and epigraphic activities are carried on. An important and necessary piece of work, that of making an inventory of the antiquities on hand, was considerably facilitated as far as Java was concerned, because the Service could dispose of the above mentioned work by Dr. VERBEEK; local investigations supplemented his statements, and so the inventories of the Javanese antiquities have come into existence which now only have to be kept up to date As far as the other islands are concerned the making of inventories has been started in Bali [1]); for the rest of the Archipelago a provisional list [2]) exists, drafted from literary evidence, but an inventory checked by local investigations is to follow.

With reference to the actual care of the monuments the Service with its limited staff has only been able to work with might and main as far as Java is concerned. The distribution of the principal remains in two large groups in Central- and East Java naturally led to the institution of two archaeological departments under the superintendence of an architect as inspector (or assistant inspector), who lives on the spot. At present the two officials in function are P. J. PERQUIN and B. DE HAAN, by whom most of the activities sketched below are being conducted. Except for urgent cases, when immediate action towards the preservation of a monument is essential, each of them is engaged in inspecting gradually and systematically all the places of archaeological interest in his division, in cleaning and technically examining the

[1]) Oudh. Versl. 1925.

[2]) Oudh. Versl. 1912 and 1914.

monuments, applying measures for restoration if necessary, in looking after subsequent conservation and supervision, in making complete surveys of the buildings and other remains, in carrying on investigations throughout the area and in continuing controlling the conditions when the work is finished In that way it is hoped gradually and intensively to treat the whole of Java.

Western Java, archaeologically far less important, is provisionally being treated direct from the head-office, if necessary; the same is the case with the islands outside Java as there is not enough staff to appoint permanent inspectors there. From time to time rounds of inspection are held, and when desirable a definite task is temporarily carried out by special order; in that way for instance a few steps have recently been taken with a view to the protection and investigation of the little temples in Tapanuli at Sumatra's West-coast. A particular inspector appointed for special services (at present in the person of the above mentioned Dr. VAN STEIN CALLENFELS) has recently nearly exclusively been engaged in prehistoric research work.

It stands to reason that it is not possible to keep all remains intact. There are some which would not be worth the costs of further care, unimportant foundations for instance, and these are left to their fate as soon as all details which are of use scientifically, have been accurately recorded. The custody of the antiquities which must be preserved is a question causing constant care. Only in the case of the few most important ones it is possible to appoint European custodians; a great number are entrusted to the cares of a native guardian, but far too many are left, which, notwithstanding permanent control, fall a prey to Easterns keen on building material, or to Westerns who make a practice of collecting souvenirs. Unfortunately the provisions of the law are altogether insufficient. It was the intention to make a list of classified monuments as has been done in other countries leaving it to the Service to advise removal from or extrance into that list. Draft regulations were drawn up years ago, but have not been promulgated yet, because the government wished to await the provisions of the Monuments' protection Act in the Netherlands which are also being postponed a long time. Although at present a definitely stated violation of archaeological remains can be punished, the general regulations are for the rest confined to the already mentioned prohibition of exportation of antiquities, except for the consent of the competent authorities (it is difficult to enforce such a prohibition in the case of small objects), and to orders in connection with finds, founded on the principle that the whole value of the find belongs to the finder, but that the government reserves the right to buy the object for the museum at Batavia or at Leyden.

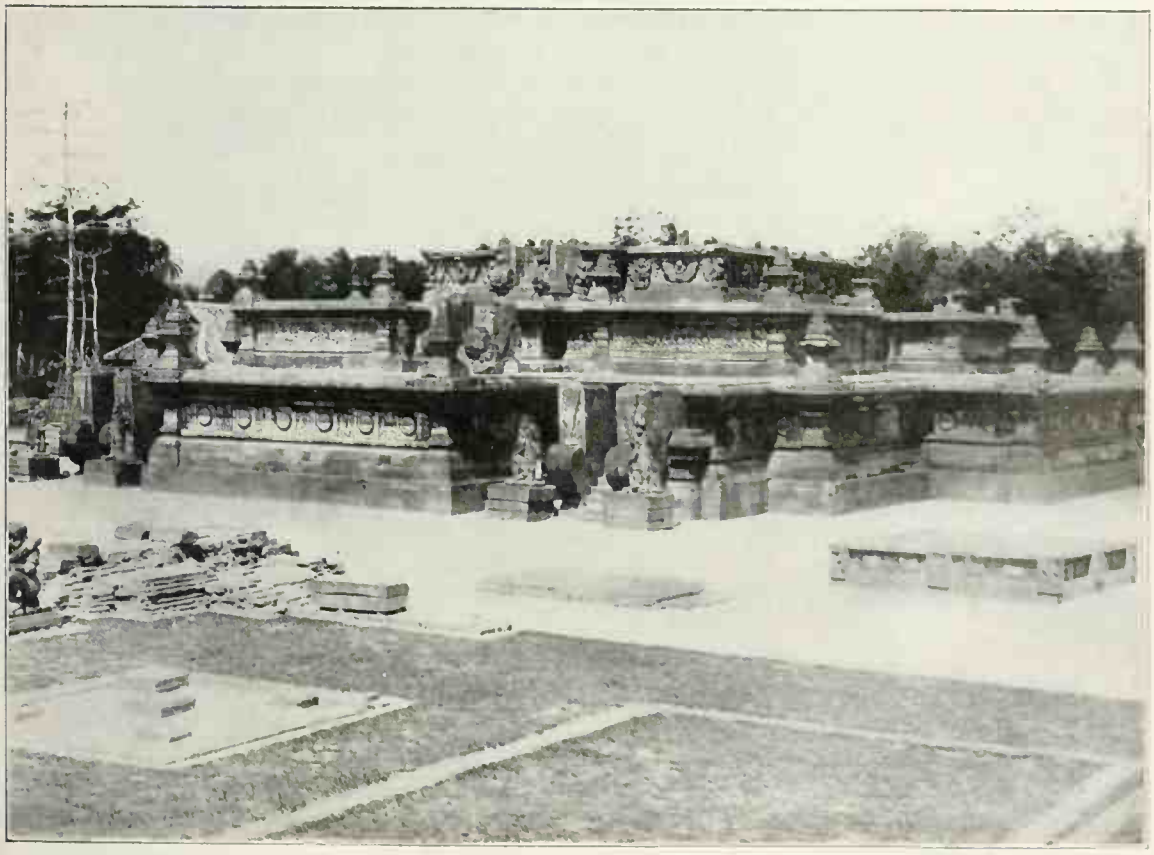
Up to which point now ought the measures for the reconstruction of a monument to be carried on, should the case arise? That is a question which has been discussed during many years and which is of great practical importance. Ought one to limit oneself strictly to the conservation of that which actually remains, or ought one to try, if sufficient data are on hand, to reconstruct the building to its old condition?

As we learnt, BRANDES always reconstructed as far as possible; this matter was in fact no problem to him, for in those years the advantages and disadvantages had been hardly considered even in Europe. But apart from mistakes possible in the course of every reconstruction, which once realized in stone cannot be redressed, the opinion was steadily gaining ground, that reconstruction as such impairs the building as a document, and can never be demanded, but at the most tolerated by Science. Hence that the instructions for the Archaeological Service exclusively and purposely turned on measures towards guarding the antiquities against further decay. Exceptions were possible where, as was the case with Barabudur, great aesthetical interests were at stake, while the chance of making mistakes was negligeable. But they had to remain exceptions.

When the direction of the Service went over in other hands in 1916, a reversion to BRANDES's methods took place, and the conception was adhered to, that reconstruction, with the intention to show the original idea of the architect, was not only permitted, but even a duty, as long as certainty could be gained concerning the old condition by means of stones found among the debris [1]). When the antiquities themselves began to show the signs resulting from this conception a protest was made against this breach of the rules, and the Government was called upon to decide on principle. The latter approved of the newly followed course of action. Wherever reconstruction into the original condition proved possible it was to be advanced. Besides this question as such, there could be a difference of opinion about the *way* in which reconstruction ought to be carried out, and up to which point it should be done, a matter which was especially and of immediate and practical interest with reference to the restoration of the Lara-Djonggrang group at Prambanan that had been going on for some time. In this matter the Government was guided by an Advisory Committee, appointed in 1924, whose report was handed in, but not published; it had to provide directions for further measures. In connection with this new decision the instructions of the Service were revised;

[1]) See the periodical Djawa 2 (1922) and 4 (1924).

Principal sanctuary at Panataran before the restoration.



Principal sanctuary at Panataran, restored.

not only would it have to trace and excavate the antiquities, to make surveys and inventories, to write descriptions of them, and to keep them under supervision, but from the present onwards (1927), it would have „to concert and execute measures towards the preservation, *casu quo reconstruction* of the antiquities". A new Archaeological Committee assists the Director of the Service in all architectural and cultural matters connected with the care and the tracing of the antiquities.

We begin our survey of the principal activities of the Service with an antiquity, where the work of reconstruction has been finished according to the new ideas, an achievement which does great credit to the Service, viz. the complex of Panataran near Blitar in Eastern Java. Up to 1915 a disorderly mass of remains were lying there pell-mell, and the work of man had rather increased the damage done by the neighbouring volcano and by the rank vegetation: in 1901, just before the Archaeological Committee was appointed, the principal temple of this complex had, as we saw, been taken in hand by a couple of absolutely incompetent masons and reconstructed and cemented as injudiciously as possible. By careful excavation of the area the Service caused the groundplan of the whole complex of terraces and buildings to appear from the soil, remarkable because this is the only place in Eastern Java where a whole complex has been preserved, and the drawing is totally different from the one in Central Java, while showing all sorts of points of resemblance to present day Bali. The damage of 1901 has been made good as far as the principal temple is concerned and the old crowning turrets at the corners of the terrace been put in their proper places, not without careful researches made into the history of this architecture. The small temple, which on our photo now shows a high upwards sloping roof, lacked this altogether ten years ago and finished at the cornice. The whole of the upperpart has been reconstructed mainly by means of old fragments. To another small and insignificant substructure a superstructure was added of exceptional style, the building being ornamented with standing figures of men, bearing big twisting snakes. A bathing place of which the undermost cisterns were dug up from the soil was fitted with its crownings and gargoyles and has become a living building again by means of the restoration of the water-works. Thus Panataran has been without doubt enriched to a large extent, and conveys indeed an idea of the meanings of the architects, even though this advantage cannot be gained but at the cost of what are, at bottom, partly new buildings.

Not less important is another great work, done by the Service, the before mentioned restoration of Lara-Djonggrang at Prambanan, which has called for sharp criticism and warm admiration. The work

Small sanctuary at Panataran before the restoration.

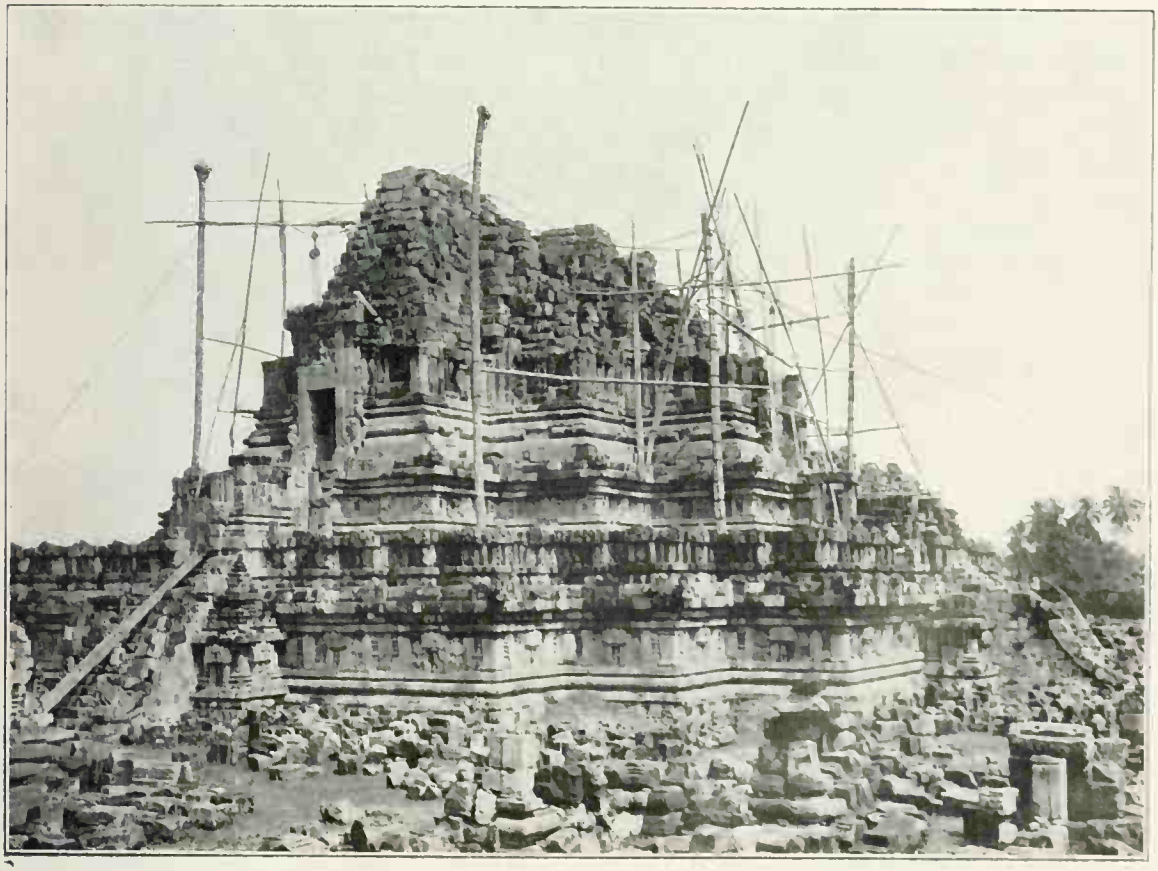
Small sanctuary at Panataran, restored.

was considerably hindered by the above mentioned mistakes during the excavation of 1889 and the following years, when the fragments belonging to eight different sanctuaries were mixed. As a result of that excavation these sanctuaries were left on the area dug up down to the basement, but only the substructure had appeared in its old condition; on top of it shapeless lumps of stone were lying, tumbled down from nearly all façades. Since VAN ERP enforced his measures at the beginning of this century there was no danger of further decay; the Service did not undertake anything but pure reconstruction, after the stones in question had been sorted out of the muddle with endless patience. An attempt was and is still being made to reconstruct the principal temple of Çiwa in the first place, but in a less degree also the adjacent temples of Brahma and Wishnu, by restoring the balustrades around the lower structures, by building up the gateways and the façades, as far as possible, as they used to be, with gargoyles, antefixes and crownings.

In a work of this magnitude, when the threatening chance of making mistakes is greater than elsewhere, and when old fragments have to be necessarily completed with new stone, exceptional care and taste are a first requisite. In some quarters there are rejoicings that in spite of all difficulties the temple is indeed arising again in its old splendour, and is beginning to show forth the architectonic effect it used to produce of old, but other circles are anxiously wondering how these buildings will ever be satisfactorily finished as far as the upper parts are concerned. Meanwhile the work is still going on, and the report of the Committee is as yet unknown, so that it would be wise to wait drawing final conclusions, until the plans have been carried out to a finish, and allow of an unbiased opinion

It is of course impossible to describe in any detail further measures taken by the Service with reference to the great number of monuments entrusted to its care, and so we shall only mention some of the most important. As such the complex of Gĕdong Sanga on the foretops of the Ungaran in Central Java may be named first, for its temples, surveyed, and where necessary reconstructed, appeared to be of great interest owing to the points of resemblance and of difference to the Diëng-plateau, which has been known much longer and more in detail, and to which the necessary cares have also been devoted. In the plain of Kedu the foundations of the temples of Ngawèn arose out of the swampy soil; one of them could partly, the other nearly wholly, be reconstructed as a typical specimen of later Central-Javanese style. Successful work has also been done with reference to the temple of Mĕrak in Surakarta where, what seemed to be nothing but a mass of debris, appeared to contain data for two now partly reconstructed

Çiwa-temple of Lara-Djonggrang before reconstruction.



Çiwa-temple of Lara-Djonggrang in reconstruction.

temples; of one of these the remarkable roof construction could be run up on the ground. While provisions were made for the principal and minor temples of the large complex of Chandi Sewu at Prambanan one of the latter was altogether reconstructed. In Eastern Java the discoveries of Badut and Bĕsuki, already touched upon in this article, were very instructive: the first, of which excavations only produced the foundations, could be reconstructed up to above the cornice; it thus demonstrates how these very early East-Javanese monuments, although reminiscent of Central-Javanese art as far as their ornamentation is concerned, yet have a character of their own when taken as a whole. A monument of which the lower parts were hidden and which had to be dug out of the volcano sand is Sawĕntar near Blitar. Deserving of special consideration is the work done in connection with the large bathing places of sacred character, those of Djalatunda and of Bĕlahan, situated on either sides of the Pĕnanggungan Mountain. In the case of the latter the fine images could be replaced into the restored niches; in the case of the first it was possible to trace the right place of the reliefs which are of such great importance from an art-historic point of view (see above), and which proved to form an integral part of the building. Finally an accurate examination took place of the area where the old capital Majapahit was situated. This investigation was carried on by a special association, formed for that purpose only, under the direction of the architect H. Maclaine Pont who, however, works in close concert with the Archaeological Service; it has already produced important results, and promises still more.

Except for these last mentioned activities the restoration of Lara-Djonggrang is the principal work the Service is having in hand at present (1928). There the girdles of the Çiwa-temple are being controlled and corrected while researches are being made into the old condition of the upper part of the temple. Further the Service is engaged in the restoration of the neighbouring sanctuary of Kalasan, where the one and only preserved façade, one of the finest specimens of the Hindu-Javanese art of composition, had to be kept out of sight for years in consequence of its precarious condition; now, however, measures are being taken thoroughly to reconstruct the building. Here also the study of the formation of the roof, which has become possible only recently, yields important and unexpected results. Among the activities in Eastern Java the completion of the researches entered upon at Singasari takes a first place; by means of a map of a century ago an attempt is being made to retrieve and to identify the remains, at the same time a few restorations of the main temple are being conducted. After that Chandi Djawi will be taken in hand, if possible; there the ruins of a temple, belonging to a combined Çiwa-

Buddha sanctuary, and very remarkable from a religious-historic point of view, are surrounded by a temple-area which so far has not been but superficially surveyed.

We have naturally not been able to mention the many detached antiquities which have been excavated either in the course of investigations, or by pure accident. One of the last discoveries, which has drawn the attention very much, is that of a silver image of the Bodhisattwa Mañjuçrî, exceptionally large and of exceedingly fine workmanship. For such objects of art the museum at Batavia is the appointed repository; it is superintended by the Batavian Society of Arts and Sciences, and it contains the greatest and richest collection of this type. Since the appearance of the above mentioned Catalogue by GROENEVELDT of 1887, its acquisitions have been yearly published, at first by way of supplement to the „Notulen" (minutes), now in an appendix to the periodical of the said association. Thanks to the semi-official relations between Society and Government the museum has been established in a Government-building and enjoys many facilities; only the exigencies of a scientific arrangement are not always sufficiently attended to, owing to the want of available room as the collections are increasing. The Government would do well to appoint a special expert to be conservator, particularly in view of the publication of this important material. The present state of affairs in which the director of the Archaeological Service is also appointed to be conservator of the museum of course guaranties scientific guidance, but it is by no means an ideal arrangement, as this functionary cannot devote more than a small part of his time to the museum.

Meanwhile not all objects, which come into consideration for preservation, are important enough to be sent to Batavia, and so local collections have a task to fulfil. The preservation on the area of the monuments, which are under continuous supervision, is desirable but not always possible. The special local museums often are a cause of anxiety, partly when too zealous collectors gather all kinds of things together there, which would have been better left at their places, and partly — which is much worse — when the zeal cools down and the collection falls a prey to neglect The best arrangement seems to be the one made at Modjokĕrto; the museum there, grown out of the private collection of the then regent (native governor) was presented by the latter to the Government, which there upon appointed the founder to be honorary conservator, charging him with the daily administration, while the Archaeological Service was entrusted with the supreme direction and control. This system, an organization by which local collaborators may be called to give an account of their actions to the Service, ought

to be applied elsewhere. One should keep in view that such collections are in no wise to be looked upon as repositories of archaeological material only, but that they have to fill an important need in educational respect, especially with reference to the native population.

Finally we must mention the publications of the Service, which give an idea of the work accomplished by it. Mention has been already made of the detailed monographies, of which three have been published: viz. on Djago, Singasari-Panataran and Barabudur. The material was of course collected in the Dutch Indies, but the publications themselves were edited in the Netherlands.

In the Dutch Indies three-monthly Reports used to appear ever since the time of the Archaeological Committee, in yearly editions in one volume, and usually combined with descriptions or studies on different subjects. In 1912 a stop was put to these mixed editions; the communications with reference to the course of activities were published each quarter in the Oudheidkundig Verslag (Archaeological Accounts), which in connection therewith used to contain short articles as well at times, but the greater and more conclusive results were reserved for the Reports.

Since 1920 the Oudheidkundig Verslag is being published in larger size, and amply illustrated; it also contains scientific contributions, on account of which the series of Reports have been stopped. For the purpose of more detailed studies these latter have been replaced by the Publications, which appear at irregular times; the first volume was printed in 1925, while the second is in the course of preparation.

Thus Oudheidkundig Verslag and Publications are produced direct by the Service. Besides archaeological articles often appear in the Tijdschrift of the Batavian Society, [1]) and in more popular form, in the periodical „Djawa". For a regular list of writings and articles may be referred to the Annual Bibliography of Indian Archaeology, which is being edited by the KERN-Institute at Leyden from 1926 onwards.

[1]) The leading periodical published in the Netherlands is the „Bijdragen" of the "Koninklijk Instituut voor de Taal-, Land- en Volkenkunde", above mentioned.

# A SURVEY OF THE HISTORY OF THE NETHERLANDS INDIES

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When one looks at the history of the present-day Netherlands Indies as a whole [1]), it appears naturally to fall into two great periods, the dividing line of which lies in about the year 1500.

In the period before that date Hinduism holds supreme sway in the most important islands, and Hindu-Indonesian states are prospering; towards the end of the fifteenth century the Islam has greatly superseded Hinduism, and at the same time the first conquerors from Europe, the Portuguese, reach India. When subsequently the Netherlanders appear on the scene in 1596 their arrival does not seem to distinguish itself from those of so many other adventurers from the West, but quite early in the seventeenth century the Dutch East India Company is found to be acting as the principal political power in the Archipelago, and by the end of that century it has gained absolute control of the country. A century later still this trading Company has come to fall and the colonies are annexed by the State, so hat in the nineteenth and twentieth century they are found to form part of the Kingdom of the Netherlands.

The history of the Archipelago begins with the arrival of the Hindus. What goes before belongs to the province of pre-history. With regard to the present state of these studies reference may be made to the chapter on archaeology.

About the beginning of our era, perhaps a little earlier, Hindu merchants, especially from the South of British India, came to the islands; they partly settled there, married the Malay-Polynesian population, and in general brought that population into touch with the Hindu civilization. On the whole, though in varying degrees, the inhabitants appeared willing to adopt this foreign civilization, and so the Hindu influence began more and more to establish itself in the areas which proved most favourable to this process, most of all in the government

[1]) The principal Dutch works on this history are: H. T. COLENBRANDER, Koloniale Geschiedenis (1925—1926) and N. J. KROM, Hindoe-Javaansche Geschiedenis (1926).

centra and among the leading circles, bringing about a gradual change which resulted into the formation of the first Hindu-Indonesian states.

From Chinese records scientists have endeavoured to conclude that such states were in existence as early as the beginning of the second century, possibly even in the first century, and at the same time the Alexandrian geographer Ptolemy was acquainted with the name and the position of Iabadiou, i.e. the island of Java, though it is not certain whether present-day Java, or Sumatra was meant by it.

Direct data of the islands themselves do not reach back further than the fourth century, in the shape of Sanskrit inscriptions in the Malay Peninsula, on the East coast of Borneo (in present-day Kutei), where king Mûlawarman appeared to reign, and in the West of Java, the kingdom of Pûrnawarman, which bore the name of Târumâ; the Tarum is still at present the principal river in Western Java. Chinese records of the same time, or of a somewhat later date, confirm the existence of such states in Sumatra and in Bali as well. When in 414 the Chinese pilgrim FA HIEN arrives in Java (or Sumatra) he finds there a Hinduized society with but few of his Buddhist coreligionists, but before ten years have elapsed an intensive propaganda for Buddhism begins.

The ups and downs of these oldest states are not known to us in detail. The one in Borneo seems soon to have come to an end, and in Java the centre of civilization moves from the Western to the central regions of the island. There, in Central Java, lies the empire of Kaling of the seventh century; there is the origin of the Old-Javanese records which have been preserved since 732, and it is also the birthland of the oldest Hindu-Javanese art, discussed in the article on archaeology. Also in Sumatra conditions are changing when in the course of the seventh century one of the coastal states, the empire of Çrîwijaya in the present-day Palembang, gradually succeeds in gaining the supremacy over the neighbouring countries. First it subjects the competing state Malayu (now Djambi), then the Interior and the island Bangka, and subsequently it asserts its influence on the other side of the straits in the Malay Peninsula. So the first naval power of the Archipelago comes into existence, the dual-empire of Çrîwijaya, important on account of its position on both sides of the great trade-route between India and China, which it is able absolutely to control in the Straits.

Under the dynasty of the Çailendra's we see this empire spreading its influence as far as Further India, and coming into close relations with Java. The latter happens in about 750, when also in Central Java a Çailendra comes into power; how exactly the political relations were does not appear, but the cultural influence of the Sumatran empire is

very evident. At the same time a more national-Javanese government comes into power in Eastern Java. When, after a glorious century, the Çailendra's retreat from Central Java, this Eastern Javanese rule spreads its influence also throughout the centre of the island, so that, in the second half of the ninth century, a great Javanese empire seems to be coming into existence.

But after a few decades it is checked in its growth and forced by forces, unknown to us, to abandon the Central Javanese parts of the empire altogether. Central Java is then reduced to insignificance; since 927 the Hindu-Javanese culture has its focus in Eastern Java exclusively, under the auspices of the Içâna-dynasty, founded shortly after the above mentioned year by king Sindok (929—947). It is one of the latter's successors, Dharmawangça, who considers himself powerful enough during the last years of the tenth century to get Java not only to subject Bali, but also to embark on agressive foreign politics against mighty Çrîwijaya, and to send an army to Sumatra: after some initial success this must, however, be called back again, and a few years later the Javanese king himself is attacked and ruined together with his empire (1007). It is under the same sovereign that we begin to see some signs of Old-Javanese literature, while he also distinguishes himself by having the law put on record.

After a period of confusion in the Javanese state of affairs Dharmawangça's cousin and son in law, Airlangga, sees an opportunity to restore the empire, an opportunity which presents itself to him on account of the temporary impotency of Çrîwijaya, which itself is being invaded by the fleets of the South-Indian Chola-king. That invasion takes place in 1024 and is especially directed against the oversea's dominions of Çrîwijaya, which are centred in Katâha (Kĕdah). After a few years the Sumatran empire has redressed itself, but meanwhile Airlangga, since 1019 ruler of a small state near Surabaya, has begun his campaigns towards the reunion of Java, which were crowned with a complete success in 1035. Western Java, however, is entirely left out of it; here exists at that same time the independent state of Sunda. In the long run it comes under Sumatran influence without any opposition from the side of Airlangga's successors. In the contrary, taught by experience, Çrîwijaya and Java assume, as it were, a kind of balance-politics, whereby the first mentioned state maintains the Western part of the Archipelago, while Java gets the opportunity to spread its power throughout the Eastern half of the complex of islands. Herewith begins at the same time the great Javanese sea trade, repeatedly mentioned in the inscriptions from the 11th century onwards.

At his abdication in 1042 Airlangga divides his country between his two sons, and the two empires of Kadiri and Janggala come into existence; the latter soon loses its importance, so that the subsequent period is called that of Kadiri (1042—1222). It is a time of great splendour, the golden age of chivalrous poetry, and of ever increasing prestige abroad; the best known of the Kadirian kings is Jayabhaya (1135—1157). At the end of this period a Chinese record states that the Archipelago is divided into two spheres of influence, and that Java indeed rules the East, as Çrîwijaya has long since ruled the West.

In the year 1222 the internal Javanese policy undergoes a great change in consequence of Kadiri's fall being attended by the discontinuance of many old traditions. In the vicinity of presentday Malang an adventurer from the scum of the people, Angrok, had craftily managed to usurp local authority and steadily to increase and extend his power over his environment, until, making use of a conflict between the Kadirian king and the clergy, he dares to renounce his allegiance to the central authority, the king. After a short campaign the battle of Gantĕr (1222) decides in his favour, and as king Rajasa he ascends the Javanese throne. His dynasty, which would be in power for three centuries, is that of the Girîndras; his capital is situated at Singhasâri. In this time the series of architectural works of the East-Javanese art are begun.

Of the kings who resided at Singhasâri, the last one, Kĕrtanagara (1268—1292) is a noteworthy figure. Deliberately he resumes the Javanese expansion-politics, also to the West, and gets a firm footing in the Malay Peninsula and in Sumatra. Çrîwijaya is no more capable to resist and has to submit to the fact that her possessions on the other side of the straits fall into the hands of Siam and of Java, and that, after a successful Javanese expedition begun in 1275, even in Sumatra itself old Malayu (Djambi) becomes a Javanese dependency, out of which the Javanese influence can spread steadily. On account of his independent attitude, Kĕrtanagara himself comes into conflict with the Chinese Emperor Khubilai, who, from the time of his accession to the throne in 1278 onwards, has been making a point of asserting China's power in the Southern Seas; an insult offered to his ambassador from Javanese quarters caused the emperor to determine on a punitive expedition. When the latter landed at Tuban in 1292, Kĕrtanagara had already disappeared; the rebel viceroy of Kadiri, descendant of the old royal family, had taken possession of the kraton at Singhasâri, Kĕrtanagara had perished during the attack, and a restored Kadirian empire had established itself.

It would be but of short duration. Kĕrtanagara's son in law and next

of kin, Wijaya, made a masterly use of the arrival of the Chinese by securing their help against Kadiri and taking that town with their assistance, after which he succeeded in as masterly a way to get rid of his allies, who put to sea after having suffered heavy losses. Under the royal name of Kĕrtarâjasa (1294—1309) Wijaya is from that time onwards master of Java, which he rules from his new capital Majapahit.

The empire of Majapahit is the best known and the mightiest of ancient Java; its golden age was in the fourteenth century under king Râjasanagara, or, by his Javanese name, Hayam Wuruk (1350—1389), and under the preceding regency of his mother Tribhuwanâ (1329—1350), thanks to the excellent governing capacities of the imperial chancellor Gajah Mada, who assisted both sovereigns from 1331 until 1364. About the Javanese empire of those days we get excellent information from the panegyric poem Nâgarakĕrtâgama, which was written in 1365 in honour of the king, and which has preserved for us a great many particulars in every sphere.

In more or less peaceful ways the whole Archipelago was forced to acknowledge Java's supremacy, which also spread throughout the Southern part of the Malay Peninsula. In 1377 Çrîwijaya ventured a vain attempt towards recapturing its independence, a course of action which it had to pay for with a complete downfall; Malayu, which was ever expanding under its own viceroys, was the principal Sumatran dependency; in due time, after the transference of its seat of government to the Padang Highlands it would grow into the empire of Mĕnangkabau. Also Western Java, where a new Sunda state had arisen in 1333 with its capital Pajajaran near Buitenzorg, had temporarily to submit to Majapahit, and Bali too was colonized by the Javanese. Excellent measures with reference to the internal government, to public works, jurisdiction and taxes completed the organization of the empire.

This golden age was relatively soon followed by decay and ruin. Disputes concerning the succession to the throne and civil wars enfeebled the empire and caused its hold on the outposts to relax, but an important factor beside those things was the spreading of the Islam.

As early as the end of the thirteenth century some small states at Sumatra's North Coast had been converted to the Islam out of Gujarat in British India, but the new religion did not become a power of significance until it found a stronghold in the important trading port of Malacca which, established towards the end of the fourteenth century, soon became a rival to the Javanese ports, while becoming at the same time a centre for religious propaganda. Together with the spice-trade the Islam was taken from here to the Moluccas and to the coasts of Java and Sumatra; and, while records of the first years of the fifteenth

century prove the new creed as far as Java was concerned; to be adhered to by immigrants only, it was widespread in the seaport-towns towards the end of that same century. From the nature of the thing this promoted theo losening of the bonds with the central authority. It is not certain whether the latter was up to the end resident in Majapahit; in any case it gradually lost its importance, and finally its downfall was effected with little trouble, by a coalition of minor Islamic princes from the coastal towns This probably happened in about 1520 — the last certain records of a Hindu Lord paramount are dated 1513, — and in the same time the coasts of Pajajaran in Western Java embraced the Islam. Majapahit was succeeded as principal state of Java by the Mohammedan Dĕmak under king Trĕnggana (+ 1546), while here and there in the interior, and especially in Java's Eastern provinces, Hinduism continued to maintain itself for the time being. And never could it be driven away from Bali, where it found a last resort.

In the meantime another power comes upon the stage. Among the reasons which brought the Portuguese to the East the need to control the spice trade is not the least important, and so it goes without saying that, immediately after having secured a stronghold in Goa, Affonso d'Albuquerque set sail to the Archipelago, where he succeeded in 1511 in capturing Malacca, which would remain the headquarters of the Portuguese for the next 130 years. The sultan fled and finally settled at Johor. In that same year the Portuguese fleets reached the Moluccas, where the fort of Ternate would be their centre from 1521 onwards. But at the same time the rivals appeared: via the (later) Philippines the Spaniards of Magalhães' fleet had come to Tidore, and herewith the disputes begin about the exact boundaries of the territories allotted to both nations at the treaty of Tordesillas (1494), disputes which were temporarily put an end to, when, in exchange for a sum of money, the Spanish rights upon the Moluccas were ceded to the Portuguese in the terms of the treaty of the Moluccas concluded in 1529 at Zaragoza.

Meanwhile the latter had not been idle, but had meddled with all kinds of Sumatran affairs — in that island Atjeh had meanwhile become the principal Mohammedan state — and had established their factories in other parts as well. During the turbulent sixteenth century the three powers in the west of the Archipelago, Atjeh, Johor and the Portuguese, are seen to be acting now for, and then again against each other with varying success, but without decisive results. In Java a Mohammedan state, that of Bantĕn, established itself in the West, in the former Sunda territory; at first it was closely allied with Dĕmak, but afterwards it stood on its own. Riots under Trĕnggana's relations result into Pajang's supremacy over Dĕmak from 1568 onwards.

For the Portuguese also the conditions are altering. The Spaniards definitely settle in the Philippines, where Legazpi founds the new capital Manila in 1571; the Portuguese governor of Ternate has the Sultan murdered in 1570, and its immediate result is the siege and conquest of the Portuguese fort by the people of Ternate in 1574. Since then Ternate is again a power in the East of the Archipelago, while the Portuguese retreat to Amboyna and Tidore.

When Portugal and Spain are united in 1580 under Philip the Second, on the one hand this causes both nations to support each other in the East, though not wholeheartedly — for the administrations remain absolutely separated — but on the other hand trade in the Iberian harbours is rendered so difficult to Philip's English and Dutch enemies that the latter are consequently driven to the East. English freebooters such as Drake, Cavendish and Lancaster go before, the Netherlanders are soon to follow.

In the Archipelago they find important native states in Atjeh and Ternate, while between them Macassar in Celebes is rising. In Java Bantĕn is the great emporium for the trade with East and West, but the harbours of Central and Eastern Java remain of importance too, especially since a new and strong central authority is able to put a check to the interior disturbances. It is the empire of Mataram, which in the last decades of the sixteenth century usurps Pajang's supremacy under the leadership of Senapati, and is already Java's strongest power at the latter's death in 1601, even if antagonistic feelings remain towards Mataram in the heathen Eastern part of Java, and in the great sea-ports, which are set on their own rights.

In 1595 after prolonged preparations the first Dutch mercantile marine to the East puts to sea under the command of Cornelis de Houtman. It calls at Bantĕn, a few other Javanese ports, and Bali, and although it has not much success from a commercial point of view, it furnishes evidence that direct trade is possible. Consequently a great number of other enterprises follow, and the second of these, which takes the Netherlanders to the Moluccas, where they establish their trading-stations at Banda and Ternate, already proves extraordinarily profitable.

Pacts are made with native potentates, and whereever necessary, the Dutch are able to resist the power of the Portuguese, but the rivalry among the different trading companies is detrimental to further expansion of the trade. The Statesman Johan van Oldenbarneveldt succeeds, however, in obtaining the much needed unity by the foundation of the United East India Company, which on March 20th 1602 was granted its charter by the States General.

It is a joint-stock Company, in which anybody can take shares; for the time of 21 years (later on prolonged) it is granted the monopoly of the trade East of the Cape of Good Hope, with the ensuing authorization to conclude treaties, to build and control forts, etc. in name of the Dutch Government. The shareholders are organized into six Chambers, of which, furnishing half the capital, the one at Amsterdam takes the lead. From the directors of those chambers 17 people are chosen who are charged with the management, and it is this college of "Heeren XVII"(Gentleman XVII) which governs the Company.

If herewith a unity of government was achieved in the Netherlands, in India it still left much to be desired, as the admirals of the successive fleets were every time held to be the highest authority. Although, therefore, important advantages were gained, among which the occupation of the Portuguese fort at Amboyna in 1605 must be mentioned, and the Company extended its trading relations throughout the Archipelago, even as far as Further India and the Coast of Coromandel yet there were adversities as well, especially after the Spaniards had, from the Philippines, regained a footing in the Moluccas in 1606, while also the English, who had no reason at all to acknowledge a Dutch monopoly, began to make themselves felt more and more.

The unity of Government was acquired when in 1610 the institution of the office of Governor-General, assisted by an India Council, was decided upon; the first Governor-General was Pieter Both (1610—1614). The book-keeping was concentrated in one place, the Bantĕn trading-station, but the first Governors-General did not have a fixed residence, and resided whereever their presence was most needed, usually in the Moluccas. In Java the empire of Mataram gradually grew into the only power of importance under the efficient rule of sultan Agĕng, in proportion as this monarch succeeded in getting under his direct authority all that offered resistance, first the inland provinces, then the great harbour towns.

It was high time for the Company to secure a fixed place, a centre for its trade and government, and it is the Governor-General Jan Pieterszoon Coen (1619—1623) who achieved this by the conquest in 1619 of Jakatra, then subordinate to Bantĕn, and by founding in its place Batavia, which has ever since remained the seat of the Dutch Government. Meanwhile an arrangement had been made in Europe with the English by which it was agreed upon to make common cause with each other in the Archipelago under a mixed Council of Defence; this settlement, however, produced few results, as the English did not have sufficient means at their command, and finally it was altogether annulled when in 1623 the Dutch governor at Amboyna discovered a conspiracy

on the part of the English, and tried the accused after short and informal proceedings.

With regard to the native population Coen maintained the Dutch monopoly with a strong hand, especially in the Banda Islands, and, following in his footsteps, the Company's policy has always been to see to it that its exclusive right of purchase at its own prices was not encroached upon; in order to avoid too great a supply, which might depress the market, the product was, if necessary, destroyed. In Java Agĕng of Mataram remained the principal opponent, especially since his conquest of Surabaya in 1625, by which he had inflicted irreparable damage upon the old Javanese sea-trade; but in the course of two sieges of Batavia during Coen's second term of office (1627—1629) Mataram had to retreat, and since then the Company's capital has remained unassailable.

Among Coen's successors it was especially Van Diemen (1636—1645) who enforced the former's policy with regard to Macassar, which had been the principal independent state in the East since the Moluccas obeyed to the Company, and especially with reference to the Portuguese. In 1641 the Netherlanders succeeded in assaulting Malacca, which had been blockaded a long time, thus robbing the Portuguese of their most important fortress, while in the subsequent years a successful beginning was made with the conquest of Ceylon. Just after Van Diemen's death Agĕng also died, and then the first treaty with Mataram was concluded, whereby the Company promised its assistance against common enemies. In 1652 Van Riebeeck supplied a long desired restingplace during the voyage to and from Europe by his settlement al the Cape of Good Hope.

It is then especially during the long rule of Maetsuycker (1653—1678) that it was borne in upon the Company in the course of events that it could not achieve its trading objects unless it could rule supreme whereever necessary. Of European rivals it had little to fear by then; after the fall of Colombo in 1656 the Portuguese had been driven out of the whole of Ceylon and of the chief fortresses of the Coromandel and Malabar coasts by Van Goens, and at the peace concluded in 1663 all these conquests had been left to the Company; since then only Timor-Dilly has remained a Portuguese possession. At that same time the Spaniards, with whom the peace had been made earlier, retreated from the Moluccas of their own free will in order to content themselves with the Philippines; the English although still having offices here and there, at Bantĕn for instance, did not show as much interest in the Archipelago as they had in British India, while the French could easily be kept outside the Company's territory.

So the Company had free play with regard to the native potentates. At the treaty of Painan in 1663 it succeeded in bringing the great pepper-ports of Western Sumatra over to its side, promising them support against Atjeh's superior power; in 1666 strong action was taken against Macassar which, together with all other peoples and sovereigns of those regions, had to submit to the will of the Company at the treaty of Bongaai in the following year at the end of Speelman's successful campaign against them. Fugitives from Macassar settle at the coasts of the empire of Mataram, which were also being disturbed by Madurese rebels, and the Company's assistance against them is called in by the Susuhunan in virtue of the terms of the treaty of 1646. It is given, but at a high price. At the contracts of 1677 and 1678, drawn up by Speelman, and finally accepted by the Susuhunan's successor after the former's flight from his capital and consequent death, territory East of Batavia and also the town and country of Semarang are ceded to the Company, all sorts of important trading advantages are granted, and the Susuhunan is so deeply indebted to it that he has to lend his harbours on security. The prince is reinstated in a new capital, Kartasura, but to all intents and purposes it is the Company which controls the empire of Mataram.

Interior disturbances were in 1684 the immediate cause that Bantĕn, the empire of Western Java, which had been Batavia's rival for such a long time, and which had been left alone from fear of European complications, was also bound to the Company by a rigid contract; in consequence of its monopoly the foreign trading stations disappear, and the English settle at Sumatra, where in the long run Bengkulen becomes their head-quarters. Also in Borneo and in other places the Company now makes itself felt as the final authority in the Archipelago. It acquired this position for itself in less than a century.

Now the point was to maintain and to strengthen it. With regard to Mataram the repeated wars of succession, in which the Company had to interfere, offered good opportunities more and more to tighten the relations, but elsewhere also, for instance in Palembang, contracts with regard to the monopoly were concluded. If, therefore, the seventeenth century was one of exploration and conquest, in the eighteenth century the question was to profit of all that had been acquired. To the old trade in spices, pepper and rice — whilst cloths from British India and opium were imported — new products were added, sugar and especially coffee. It was in particular the supply of the latter by the population to its heads, and by the heads to the Company, which gave occasion to all kinds of misuses, but also in other respects the

badly salaried officials began to enrich themselves by means of all sorts of illicit emoluments and extortions.

The monopoly-system, which was rigidly carried through, facilitated these things; the attempts, made from time to time to get a category of free-citizens or colonists to contribute towards the prosperity of the country, have failed. So a European intermediate trade has not come into existence, but instead of that the Chinese element began to play a prominent part, even to the extent that the presence of the great number of Chinese in Batavia was deemed a danger, and that riotings among Chinese outside the town led in 1741 to a wholly unwarranted massacre of these industrious co-citizens within the town.

The Governor-General Van Imhoff, who assumed office in 1743, was faced with the task to restore the peace and to put an end to the worst of the abuses; he did not succeed with regard to the latter for his measures were not radical enough to get at the root of the evil. His rule is of importance with reference to the development of the relations with the empire of Mataram, which was being disturbed by the Chinese and by dynastic disputes; after Mataram had successively ceded Eastern Java and all coastal regions, the Susuhunan gave the whole of his empire to the Company at his deathbed in 1749; his successors did not rule but as the Company's representatives. The quarrels in the house of Mataram were settled at the Company's command by means of a division brought about in 1755, whereby the two present-day Principalities ("Vorstenlanden") Surakarta and Jogjakarta came into being; in 1757 another split took place by the creation of the Mangkunĕgara principality, which also is still extant. Its newly gained expansion of territory forced the Company to drastic measures in the sphere of organization, government and jurisdiction. During the second half of the century the Company is still seen to maintain its vigorous line of action with regard to the native rulers, for instance at Sumatra's East-Coast, in Western Borneo and in Ceylon, but it can no longer resist a European enemy, which is fully borne out when it tries to oppose Clive in Bengal in 1759. Attempts at reform on a small scale go with measures to get into a better state of defence. But when the war with England is declared in 1780 it appears to be too late.

The closing-down of its British-Indian offices, the destruction of its ships upon the sea and the interruption of its communications with the East entail such enormous losses that the Company is forced to ask suspension of payment; the State is called upon to help and does this reluctantly, and on onerous terms. And even after the peace is made, at which free navigation has to be granted to the English, it does not become again what it used to be; its bad management and wrong

dividend-policy, the consequences of the monopoly-system, the bad elements among its servants, the lack of supervision, and above all the abuses bound up with its system of emoluments are beyond repair. But when recording these debit entries, one sometimes forgets that against it must be put the credit of having founded an over-sea's empire and having attained the sovereignty in the Archipelago.

While plans were still being devised towards the improvement of the Company's administration, the seditions in the Netherlands began which resulted in 1787 into a provisional restoration of the authority of the Stadtholder, followed by an English treaty in 1788; at that treaty it was settled that in the case of a European war both contracting parties would be allowed to occupy each other's colonies against a common enemy. A few years later a Committee with Nederburgh as chairman went to the Dutch Indies in order to settle the affairs there upon the following basis: the defence would be left to the Government and the navigation within the Archipelago to private enterprise, while the levy of taxes would give a sound financial basis. The first part of that programme had in fact already been put into operation in 1783, when a Government-squadron had been sent from the Netherlands to quell the riots in Johor and Riau.

In 1795 the French were acclaimed in the Netherlands, and the Stadtholder was driven away; the new republican principles could not allow the existence of a trading-concern run as a monopoly, and so the governing directors of the Company were immediately replaced by a State Committee. The Stadtholder, to whose dignity the supreme directorship of the Company was attached, and who had taken refuge in England, now published letters in which (on the ground of the above-mentioned treaty) the men in authority in the Dutch Colonies were ordered to let in the English against the French enemy. Successively the Cape, Ceylon, the Western offices and the greater part of the Dutch Outposts fell into English hands.

The interruption of the communication with the Netherlands was cause that the revolution did not find an easy access into Java, and that Nederburgh could remain master of the situation without difficulty. The chief representative of the new ideas, Van Hogendorp, had to leave the country, and continued his propaganda in the Netherlands. These ideas he had partly picked up in Bengal; the Javanese was to be given private landed property and the produce-trade had to be left entirely free, the system of emoluments was to be replaced by decent pay, and above all were forced labour and forced delivery to be abolished and to be replaced by a landtax.

When in 1798 the first constitution of the Batavian Republic ceded the colonies to the State against an indemnification, the old system of

administration had to be maintained for the time being, untill it would have been decided how the new principles were to be introduced into the Batavian Indies and a new charter would have been worked out to that effect. That this could be more than a dead letter became clear when, at the peace of Amiens in 1802, the lost colonies were returned to the Netherlands just as they were before, with the exception of Ceylon. The charter became a compromise which accepted the new ideas theoretically, allowing, however, of exceptions which rendered it fairly well illusory. Meanwhile Louis Napoleon's Kingdom of Holland had been founded in 1806, and, in connection with the renewed condition of war with England, his imperial brother did not wish to entrust the Colonies to a reformer, but rather to a general. And so Marshal Daendels assumed command (1808—1811).

Daendels distinguished himself by making a clean sweep of mouldy Company rubbish, and it seems symbolical that he had the old Castle of Batavia pulled down in order to transfer the government seat to Weltevreden. His first and principal care had to be directed on the question of defence; as soon as possible a beginning was made with the construction of military works, and the building of men-of-war, while measures were taken to arm the natives on a large scale in order to provide a backing for the relatively small European army. It was also chiefly with a view to military ends that the great highroad was made, which traverses Java through the whole of its length, from Anjĕr to the East Corner. The work was achieved with forced labour and at the cost of considerable sacrifices, but in a short time an excellent communication was established, which could soon prove its uses in other than military respects as well.

Forced labour, much needed by Daendels for his drastic measures, was not only maintained, but even applied to a greater extent, and the system of forced delivery remained as much in force as it ever was before. It is true that abuses were checked, if necessary with rigidity. The native heads were looked upon and treated as officials; the European staff, graded in a new way entirely different from the one instituted by the Company, had to forgo all the usual emoluments, but they were compensated by decent salaries. All this was attended by a new division of Java which, to a large extent, formed the basis of the present-day one, and by a total re-organization of the judicature.

In Daendels's system was no room for a native government with some degree of independence, and so the native sovereigns were in a great measure deprived of whatever power they still possessed. A conflict with Bantĕn, brought about on account of military measures, led to the whole of the sultanate being declared government property,

and the territorial curtailment of what was left in the matter of the sultan's power. Likewise Surakarta and Jogjakarta had to submit to the fact that the European Government took the lead in all matters, and that the latter's superiority also showed in outward ceremony. The troubles which did not fail to come in this case as well put the rich province of Kĕdu into the hands of the Government.

Daendels's reforms cost a great deal of money, and made him many enemies. In order to meet financial difficulties he often had to act against his principles; so he brought himself to alienate large pieces of crown-land, in consequence of which a number of private estates came into European and Chinese hands. His enemies' complaints led to his recall in 1811.

But by then the fall of the Dutch rule was imminent; in English quarters schemes had been on hand for some time to take possession of the Dutch-French colonies, and the man who played a prominent part in that matter was Thomas Stamford Raffles, at that time British agent at Malacca. He is the person who prepared the English expedition against Java in 1811, which landed near Batavia, and which, in spite of the resistance offered, forced the weaker Dutch and native troups to capitulate. In September 1811 Java and its dependencies went over into English hands.

Raffles was entrusted with the government of this part of the Archipelago in the capacity of Lieutenant-Governor (1811—1816), a position which allowed him a free hand in many respects, although he was subordinate to the Governor-General in Bengal. The two other pieces of the Archipelago, which formerly had been Dutch, Malacca and the Moluccas, were in the same condition; the fourth piece, Bengkulen in Sumatra, was a part of the Bengal precidency itself. The importance of this period, however, is centred in Java and in the person of Raffles, whose rule comprises the whole of the English interregnum except for a couple of months.

As far as administration and jurisdiction were concerned Raffles partly followed in the footsteps of Daendels, but in other respects he took his own line and introduced English methods. He especially made his mark by the reforms he brought about in the governmental system, where he succeeded in carrying out the same ideas which were once suggested by Van Hogendorp. His system is based upon the theory that the native sovereign, and consequently his successor, the European Government, is the owner of all the land, and that he leases this to the cultivator. The lease bears the name of „land-rental" and consists of $^2/_5$ of the rice production; it is levied by the village, though later on Raffles tried to introduce an individual assessment. All

other taxes, forced labour and forced delivery had to be abolished, whether they were due to the government or to the native heads. As civil servants these latter were to receive a monetary payment from the state.

At first this reform did not answer very well in practice; the data in connection with the assessment were totally wanting and the number of officials, charged with the introduction of the new regime, was too small; they were besides inexperienced and so they consequently remained dependent on the heads. The result was great arbitrariness and the imposition of the new taxes, while for safety's sake the old ones were allowed to continue, thus increasing the burden.

Yet and notwithstanding the defects of his system Raffles laid the foundation of modern colonial government. In consequence of unavoidable mistakes financial success failed to come, and this was the reason that Raffles did not succeed in convincing his fellow-countrymen of the desirability to keep Java, when the question of a restitution of the colonies presented itself.

The abolition of the slave-trade, — not yet slavery —, is another of Raffles's merits. In the matter of the sale of land he followed Daendels's bad example, and in his rigid attitude towards the royal courts he also continued the former's policy; Jogja, whither an expeditionary force had to be sent in 1812, had to resign to a split by which the Paku-Alam territory came into being, which is still extant. Disturbances in Palembang, in the past instigated by Raffles himself against the Dutch government, had to be suppressed by him at a later date, and resulted in a contract by which he managed to secure Bangka and Billiton.

Meanwhile the restoration of the Netherlands' independence had taken place in 1813, and at once negotiations for the colonies were entered upon which were ended by the London convention of 1814. What the Netherlands possessed in 1803 was returned to them, except the Cape (as far as the East was concerned); they would, however, exchange one of their British Indian possessions (Cochin) against Bangka.

The newly founded Kingdom of the Netherlands (which included present-day Belgium) sent three Commissioners-General to settle matters appending the restitution; they governed from 1816—1819, after which one of them, Van der Capellen, remained behind in the capacity of Governor-General (1819—1825). With the restitution of the colonies, of Java in 1816, and of the Outposts a little later, a new Dutch period begins.

Not everywhere did the restoration of the old conditions run

equally smoothly, especially as Raffles, now serving English interests at Bengkulen, did not neglect any opportunity to inflict damage on the Netherlanders. That no further consequences were involved was especially due to the fact that the authorities at Calcutta did not support him, except in one case, that of Singapore. Realizing the great future of a emporium in that region, Raffles made use of the circumstance that two brothers laid claims upon the sultanate of Johor; by supporting the very one who had not been acknowledged by the Dutch government. he persuaded this prince so cede the country in question to him. There he forthwith started his settlement, and no Dutch protests availed to drive him out of it.

With regard to the interior regulations the Commissioners-General were first of all faced with the question as to what was to be done in the matter of the new system of land taxes. They finally maintained it with an improvement of the assessment according to a method (the so-called system of higgling) which, though instituted provisionally, has since remained for a long time. Former productions, the condition of the crop and the particular circumstances would be taken into consideration. The tax would again be levied by the village, permission being granted to pay in money or in kind, according to their own choice. With reference to the government cultures maintained by Raffles, the Preanger Regencies, the region of the important source of revenue, the coffee, were left to carry on as before, but for the rest compulsory cultivation with free-sale by the population was enforced: a method which turned out wrong altogether. Then, when re-organizing the government staff, the offices were not re-instituted according to the plan evolved by the Company, but the British system was adopted and continued. And further it was hoped at the outset that private enterprises would develop, until Van der Capellen, fearing competition with the Government cultures, made a stand against it.

The troubles about Singapore, and other questions, arisen since the restoration, for instance the point whether Billiton belonged to Bangka, which had been given in exchange, or whether it did not; further the protective measures of the new government which were detrimental to England, made it necessary to come to an understanding with this country, and this finally took place by means of the so-called Sumatra-treaty of 1824. Exclusion of mutual trade was prohibited, although the Molucca monopoly of the spice-trade remained in force for the time being; the import duties were regulated (not more than double the amount the own nation paid, and not more than 6 % in the case it was free); the Netherlands gave up Singapore as England did in the case of Billiton; the Dutch trading stations in British India came to England, and the

English ones in Sumatra to the Netherlands. England would not settle South of the Straits of Singapore, and the Netherlands would keep away from the Malay Peninsula, where Malacca was ceded. And with regard to Atjeh, with which Raffles had concluded an exclusive treaty, it was finally decided by note that the Netherlands were to keep in check the piracy practised by that state while yet maintaining its independence.

At the same time that the difficulties with England definitely came to an end an attempt on a large scale was made in the Netherlands on the king's initiative to put commerce on its feet again. The „Nederlandsche Handel-Maatschappij" (the Netherlands' Trading Company), founded in 1824, was to ship to the Netherlands the government's products, which would also be consigned to the company, while thus far they had been sold by auction in the Netherlands Indies; in that way there would again be great colonial auctions at Amsterdam. In the beginning the results were disappointing but, with a tremendous increase of the government products after 1830, this trading company entered upon a time of great prosperity.

While Van der Capellen had given his attention to the Outposts as well, renewing old relations everywhere, in some places at the request of the population, in others of his own accord, and, if necessary backed by military support, it became necessary, after he had been recalled on account of his financial measures, to keep chiefly to Java, where a dangerous rebellion broke out in Jogjakarta in 1825. As there was a great deal of discontent — among the nobility in consequence of the Government's ill-advised prohibition of the profitable lease of land to Europeans, among the lower classes on account of extortions which they had to endure at the hands of the Chinese toll-farmers — the leader of the revolt, Dipo Negoro, in a short time managed to set in a blaze nearly the whole of Central Java, and peace was not restored until1830. The Principalities were then reduced to the size and significance they have at the present day.

All this cost a great deal of money, and soon more money would be needed in connection with the King's maintenance-policy towards Belgium on account of the latter's secession. A couple of times the mother-land had negotiated loans on behalf of the Indian finances, but they were only of temporary use. At first it was supposed that Java's prosperity would be promoted by placing the waste lands at the disposal of European capital, but in 1830 the King gave his consent towards a totally different scheme, which was to be introduced by its propounder Van den Bosch as Governor-General (1830—1834).

Van den Bosch's socalled culture-system dictates that the popul-

ation cede one fifth of its rice-fields for the cultivation of products which are suitable for the European market; it is to cultivate this land, which is exempted from taxes, under its own heads, and to deliver the products to the government when they are ready for the market. In theory several stipulations safeguarded against abuse, but in practice they were not adhered to. When a first trial on a small scale appeared to succeed, and the money was so badly needed, the system was forced; a compulsory culture of all kinds of products was carried through, and the civil servant's career was made dependent on the success of these cultures. Much more than a fifth of the land was taken, the exemption of land-rental was not maintained, and in other ways too the native was exploited. The rice culture did not keep up to standard while the rice prices were pushed up, a state of affairs which in the long run leads to famine. Meanwhile this culture-system, which remained in force for twenty years, yielded the desired millions to the state, but these were, in the end, not used towards Indian interests, but for the benefit of the Netherlands.

The culture system brings with it that the government's interests are chiefly centred in Java. Outside Java the principal care is to maintain the Dutch authority as it used to be. This policy entailed military exploits, especially in Sumatra, the suppression of disturbances of long years' standing in the Lampongs, and action against the Padri movement in ancient Mĕnangkabau in the Padang Highlands, an agitation which had been causing trouble ever since the restitution. In the beginning of the century conflicts arose between the strict adherents of the Mohammedan law and those who kept to the old customs of the country; the government which supported the latter had to interfere on repeated occasions, but not until 1841 did it succeed in conquering the opposition.

Except for the maintenance of existing interests the circumstances made it imperative sometimes to take action elsewhere, for instance at Bali, which thus far had been left to its own devices; the way, however, in which its sovereigns, availing themselves of the ancient law of the country, took possession of stranded ships including cargo and crew, led to an armed expedition (1846—1849); although the Government subsequently drew back, it appeared in the following years that it had interfered too much into Bali's affairs to allow of its keeping aloof. It did not, however, throw itself wholeheartedly into matters outside Java. In about 1840 new settlements at Sumatra's East coast were decided upon, but, when the English took strong exception to them (on behalf of the trade at Singapore), the scheme was abandoned. Likewise Brooke's appearance in Sĕrawak, followed by the occupation

of Labuan by the English, was looked upon without heart-break.

A new phase of colonial management was ushered in by the great events of 1848, which in the Netherlands are reflected in a revised Constitution. It contained something new also with regard to the colonies: the law must state in which way colonial finance was to be controlled and accounted for, and likewise Parliament was to vote the Colonial Constitutional Act (Regeerings-Reglement) and the monetary system. In other words: in these matters, thusfar left to the King, and if needs arose also in other matters, the representation of the people was given right of say.

Although the new liberal ideas won through but slowly, the original advocates of the culture-system had gradually learnt to realize the great difficulties bound up with it in actual practice. The Constitutional Act instituted by Parliament in 1854 maintained, it is true, the cultures introduced on high authority, but after a transition period was held out a prospect of an exclusively free culture. Also the assessment of the land-tax and the forced labour question would be better regulated. With this prospect of an improvement in Java's conditions the Government adopted a more self-assured line of action outside this island. It now asserted itself much more, by force of arms if necessary, at Borneo's West and East-coast, and in Celebes, and at a renewed settlement at Sumatra's East-coast the protestations from Singapore were no deterrent any longer.

It was the minister of the Colonies, Fransen van de Putte (1863—1866), who managed to introduce several reforms. The compulsory cultures were abolished, with the exception of sugar and coffee, the profits of which could not immediately be spared. Some kinds of forced labour also disappeared. A new tariffact fixed the import-duties without distinction of flag, and only maintained the differential duties with regard to a few articles which needed protection. At the next revision of this act the differential duties were done away with for good and all. And then there was the important accounting law, according to which the Indian budget would, from 1867 onwards, be settled by law every year, thus putting it under the direct control of the Parliament.

Fransen van de Putte's attempt to introduce agrarian legislation failed and an agrarian-act was not instituted until 1870, by minister De Waal: the government was allowed to let out waste land on hereditary tenure, but it was not to encroach upon native rights; the natives may let their land to non-natives; they themselves will be able to get special agrarian proprietary rights upon land in their possession. When this law was carried out, it was further settled that all land of which the ownership could not be proved was to be considered crown-

land. The same minister De Waal also introduced the sugar-act, which dictated the gradual abolition of the government culture, sothat the sugar would be absolutely free by 1891.

So private cultures began to prosper; in the sixties the tobacco was also to be counted among them, at first at Sumatra's East-coast; preceded by the coal production, and soon followed by the oil industry. The Suez Canal had facilitated trade, and the first trains were run in Java. For great works, such as railways, harbours, and irrigation, large sums would gradually be needed, and it was no longer fair to continue using the balance of the Indian finances for the benefit of the home-country. It is again De Waal who proposed to appropriate this credit-balance for the greater part towards public works in the Indies. The Chamber passed this resolution but reluctantly, and the budget of 1877 still shows a sum set apart for the Netherlands. But it could not be paid any longer, and since then the tables have been turned. The Indies used up so much that the time of deficiencies in the budget began and the Netherlands were called upon to help by granting loans. Then people learned to regret that the Home- and the Colonial resources were not kept separate.

Apart from the public works there was also a war which was going to cost millions. The piracy practised by Atjeh had become intolerable, and as soon as a new agreement with England had eliminated the restrictions of 1824, forceful action became imperative, the more so as the sultan had already entered into communication with other foreign powers. The Atjeh-war was declared in 1873, and lasted with intervals up to well on in the twentieth century. Nor the capture of the capital Kota Radja in 1874, nor the occupation of the Atjeh-valley in 1878/9 proved to be decisive; the hostilities began anew, and in 1884 nothing better could be thought of than to retreat within a concentrated line. It would be years before this unsatisfactory and yet expensive wait-and-see policy could be abandoned.

That Java gradually became stronger economically appears from the way in which it managed to surmount set-backs such as the sugar crisis of 1884. Sumatra's East-coast too became a very important factor; especially since the territories, thus far subordinate to Siak, were ceded to the Government in 1884, which founded a government-seat at Medan in 1887. The Moluccas, however, lost much of their importance after the cultures had been decontrolled, with the exception of a short period of prosperity in Banda. The most Eastern part of the Netherlands' possessions in the Archipelago, New Guinea, where Tidore used to rule, was in these years gradually beginning to drawn the attention, also in consequence of the English penetrating into their

part of this island; in 1895 a delimitation of the frontier was negotiated.

While by measures, such as the settlement of the land-tax-assessment on a cadastral foundation (started during this period), and the substitution of some of the forced labour by a head-tax, an endeavour was made to regulate the taxes of the native population on a fairer basis, their welfare was also being promoted by irrigation, improvements in the rice cultivation, and especially by school-education. In 1892 it was decided to do away gradually with the last government-culture, that of the coffee; it came to an end in 1917. Since Governor-General Van der Wyck (1893—1899), followed by Governor-General Rooseboom (1899—1904), came into office, the Government gradually took to asserting its influence outside Java much more. The raid on an expeditionary force at Lombok was very severely punished and followed by annexation; elsewhere too, at Sumatra, Celebes and Borneo the authorities made themselves felt more and more.

Especially in the Atjeh-war the change of policy was noticeable thanks to the collaboration between the energetic military Governor Van Heutsz and the learned Atjeh-connoisseur Snouck Hurgronje. Owing to this the result of the campaigns in that province was a contact, not exclusively based upon military power, but also upon knowledge of the population, sothat the pacification of this region was brought about in 1904, while at the same time a method had been suggested by which it might be possible to act fruitfully elsewhere. It is true that disturbances still occurred in Atjeh from time to time, but the war belonged to the past.

The legislative power in the Netherlands had been chiefly engrossed in two questions: what was to be done in the matter of the financial relations between the mother-country and the colonies, and how it would be possible to shift some of the responsibilities, now that the central authorities in the Indies were burdened more and more. When the interest and the discharge of the loans contracted for the Indies appeared upon the Indian budget, the question resolved itself in principle into a separation between the two finances; in future it would no more be possible to lay a claim to eventual profits on behalf of the Netherlands either. But did not the Indies on their part have a great claim on the Netherlands on account of all which they used to supply, and was it not a duty to meet it? This point of view was gradually being answered in the affirmative; it was called a „debt of honour", and, apart from the remission of the loans, the payment to the Indies of a great number of millions was demanded. Minister Idenburg (1902—1905) proposed a solution, by entering upon the Netherland's budget the interest and discharge of the newly consolidated debt, and by using the Indian money, thus

set free, towards economical development, irrigation, agriculture, roads, etc In the end separation without further repayment was made possible, firstly on account of the great rise in prices of the Indian products since 1905 (among which rubber must be counted from 1908 onwards), and secondly by minister Fock's fiscal system, which was chiefly focussed upon capital. In 1912 the Netherlands Indies were incorporated.

Of the two ministers mentioned it was Idenburg who introduced local political divisions (provincial councils and municipal councils), to which a certain degree of autonomy was granted. With the name of Fock is bound up a new organization and expansion of school-education to the native population.

But in other respects too the Indies assumed a new aspect thanks to Governor-General Van Heutsz (1904—1909), supported by the two above-mentioned ministers. Van Heutsz is one of the most important figures in our recent colonial history. He was the person who caused the Dutch authority in the Outposts to become an authority worthy of the name, while it used to be satisfied there with a general acknowledgement, enforced, if necessary, by means of punitive expeditions He opened up these regions, and made them up to the very interior accessible to the Dutch government. From the nature of the thing military expeditions and ranging patrols had to start the work; but they were always, as soon as possible, replaced by the organs of the civil administration By means of this systematic policy Van Heutsz ensured the growth of a Dutch-Indian empire as an organized state.

Sumatra's interior, which thus far had remained independent, the little states in much traversed Borneo, Celebes, where Boni was effectively punished for having been refractory so long, Bali's sovereigns, the other smaller Sunda Islands, which had been left alone till then except for a few settlements at the coast, New Guinea, they were all in turn intensively interfered with, and have never been left alone ever since, but kept under Government supervision.

The Central Government did not appear to be sufficiently assisted in its ever increasing activities by the work of the local political divisions. Thus the initiative was taken by Van Heutsz towards another measure, by which that task could be relieved, namely by the institution of a number of great provinces, which could each take their share in the system of administration. This initiative has after all kinds of varying insight, led to the re-organization, which is in working order now, and which has caused the creation of the three great provinces of Java, with the intention that soon Sumatra, and subsequently the rest of the Archipelago is to follow. Within these provinces a certain autonomy

can now be allowed to the native administrative divisions, the regencies, to the degree which is considered necessary in each case.

The term of office of the following Governor-General, the ex-minister Ideoburg (1909—1916), made its mark by the birth of a powerful native organization and by the outbreak of the world-war. Since 1908 there had been a union of native intellectuals who chiefly propagated the extention of education; in 1911 the native commercial union, the Sarèkat Dagang Islam, sprung from a boycott-movement against Chinese suppliers; originally founded for economic purposes, it soon began to emphasize the common religion as binding principle, and when its central organization was acknowledged in 1916, it took to making it its aim to educate the native society into a nation, in order that the Indies might become in due time a self-governing state, equal to the Netherlands.

The war brought heavy burdens with it, also with regard to the Indies; trade, which saw its communication with the mother-country hindered, and sometimes even cut, had to look for other ways, and found them partly to America. The financial difficulties and ensuing shortages in the budget, did not at all come to a stop at the conclusion of the peace; in order to meet them taxes were increased, or new ones were introduced, and loans were repeatedly contracted. That these loans, now issued by the Indies in its own name, succeeded, proved the confidence rightly put into the country's economic condition.

The authorities in the Netherlands had for some years been considering how to make the non-official element in the Indies take an active part in government and legislation; if, at first, there had been a suggestion of extending the India Council, later preference was given to a separate college. At last an act in 1916 (minister Pleyte) instituted a National Council (Volksraad), an assembly consisting of Europeans, natives and foreign Easterns, partly chosen by the local political divisions, partly appointed. This Council could be consulted by the Governor-General in all matters when desired, but *had* to be consulted in matters pertaining the budget, loans, and military duties imposed on the citizens. The first National Council was opened in May 1918 by Governor-General Van Limburg Stirum (1916—1921). When in November of that year, and under the impression of the events in Europe, the Government promised the realization of some essential reforms, the democratic parties in the National Council united into a radical concentration, desiring the parliamentary form of government; finally it contented itself, however, with the appointment of a government committee, charged with the preparation of a revision of the state's polity, in which the political parties would be represented. This committee finished its work in 1920.

Meanwhile the Sarèkat Islam had developed a socialistic policy, but did not seem inclined to allow itself to be carried away by communism, which had gained ground in the Indies also; while thus the extremist organizations asserted themselves, partly side by side with it, partly opposing it, the Sarèkat Islam itself tried the combination of its two policies, the economic one, and the religious-nationalistic one, and did so with part-success: other federations of a religious and intellectual nature are existing alongside with it. In the different groups in which the native movement split, there has been a distinct tendency, latterly, towards collaboration on a nationalistic basis.

Van Limburg Stirum's policy seemed to have been focussed upon rapidly giving the natives the place due to them in the Indian body politic; too rapidly, according to some critics, who moreover reproached him with dislocating the Indian finances by too expensive measures. His successor Fock (1921—1926) succeeded in balancing the budget again; in the opinion of his critics, not without retarding the advancement of the Indies.

As far as the Dutch Indies are concerned the Dutch constitutional revision of 1922 has been done with a view to the fact that the time had come to put legislation and government as much as possible into the hands of the governing boards and authorities residing there, granting the population of the country the right to assert the greatest possible influence on the structure of these governing bodies. The alterations in the constitutional organisation of the Netherlands Indies, necessary towards the realization of the above policy, have been put down in an amendment of the Colonial Constitutional Act in 1925 (minister De Graaff). They donot go as far as the Indian Revisory Committee had desired, but although the Governor-General is still bound by „the Kings appointments", much has been achieved towards realizing an autonomy of the Netherlands-Indies as part of the Kingdom of the Netherlands.

# LANGUAGE AND LITERATURE

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**First contact with Indian languages. Malay.**

The first Indian language with which the first Dutch navigators became acquainted was Malay, which language, originally spoken in East Sumatra, spread to Malacca where it became a tongue of some literary importance. In a corrupted form it was understood in every harbour in the Dutch East Indies and made use of by Eastern traders in their conversations with Europeans and to a certain extent also in those with the native population. Before this date, in the 16th century, MAGELHAEN's Malay interpreter could make himself understood all over the Archipelago: in the record of PIGAFETTA's travels occurs a list of words of the so-called "Moors of the Moluccas", the greater part of which is Malay. In the writings of the old navigators mention is made again and again of the spread and the importance of Malay — which, however, they learned only in its impoverished form — so that the appearance at an early date of a vocabulary with conversations (by F. DE HOUTMAN 1603) need not surprise us. In the second edition, by A. C. RUIL a new element appears, viz: the desire to spread Calvinism, which led to a more thorough study of the language, to the writing of dictionaries and — though at a much later date — of grammars, the oldest of which were made in every respect after the model of Latin grammars (observationes aliquot hinc illinc decerptae ex grammatica Latina utilissimae studiosis linguae Malaïcae in insulis Java, Amboina, Moluccis, Banda et earundem circumviciniis usurpatae). A Latin version of a dictionary made by clergymen was published at Rome at the expense of the Congregatio de propag. fide. Gradually the clergymen-lexicographers constituted the class of those who really studied Malay thoroughly, in contra-distinction to many who learned a few words of the corrupted form, by means of which they could just make themselves understood during their stay in the Indies. This antithesis has called into being the wrong terms "High Malay" and "Low Malay", which have caused so much

confusion both in the practice of daily life and in the translation of the bible.

The scientific study of Malay was not possible until comparative philology and the study of those languages which had exercised a great influence on Indonesian idians were taken up.

**Study of other languages a consequence of the introduction of Christianity.**

What has been said of the study of Malay holds good also for that of other Indian languages; they began to be studied at the time of the introduction of Christianity and afterwards the missionaries proved themselves to be diligent scholars. The study of the languages of Java: Javanese, Sundanese and Madurese, of Batak, Buginese, Makassar and at a later date of the various idioms of Central Celebes, began in the same way.

The following pages contain a survey of the principal tongues together with a sketch of the history of the study of those languages. It is impossible to aim at anything like completeness in this survey and it is the writer's desire to avoid too many details.

**The family of languages.**

Wilhelm von Humboldt (1767—1835) was the first to point out the relationship between Indonesian and Polynesian languages; the name "Malay-Polynesian" languages was first used by him. Afterwards it was proved that these groups were related to the Melanesian languages. When the Indonesian, Melanesian, Polynesian and Micronesian languages are considered as belonging to one family, the area over which they are spoken must be immense, viz: from Formosa to parts of New Zealand and from Madagascar to the Easter-islands (forty degrees of latitude from the South American coast). Attempts to count the languages of Japan, the Aino's and some Americanistic idioms among this family extending over so large a part of the earth's surface, have not led to any definite result yet. All languages found in "Malay-Polynesian" mentioned above, do not belong to this type morphologically, however. In South New Guinea, Northern Halmaheira, in Ternate and Tidore languages of a quite different kind are spoken. The question whether these may represent the oldest type of language spoken by the autochthonic population (which was driven away by the invaders from the West, who spoke "Malay Polynesian" languages) though not perhaps without attraction, is altogether unsolvable. The group of the "Malay-Polynesian" languages has its relations on the Asiatic continent, notably in the country of the Tjams. This fact might lend weight to the thesis that these languages may have originated from the East coast of Farther India. An attempt

to prove this was made by H. KERN (Versl. en Meded. der Kon. Akad. v. Wet. Afd. Letterk. 3e reeks 4e deel) [1]). This remarkable endeavour to fix the birth-place of languages by means of comparative philology must be looked upon in the light of its time (1888), when such researches concerning the origin of the Indo-Germanic languages engrossed the attention of philogogers. Kern also wrote "The Fiji language compared with the cognate languages in Indonesia and Polynesia". That part of the work which compares the various languages grammatically and which has led to the important conclusion that Fiji and Polynesian form one whole as compared with the Indonesian languages is naturally more convincing than the comparative vocabulary, which cannot be considered as absolutely trustworthy in all its details, owing to the fact that the knowledge of many languages was deficient at the time of the composition of the book (1886). Twenty years afterwards the term indicating the family of languages in question was applied to a good many more tongues. In 1906 P. W. SCHMIDT published a work "Die Mon Khmer Sprachen ein Bindeglied zwischen Völkern Zentral Asiens und Austronesiens". A few years before this philologer had proved that the group of Farther Indian languages viz: those of the Mon Khmer (which is utterly different from the Chinese-Tibetan family of languages) is cognate with Semang and Sakei in Malacca, and the language of the Nicobar islands. He also confirmed the relationship — which had been established before — between this group and a family of Indian languages, to which Munda and Santali belong. SCHMIDT calls the entire family Austro-asiatic. He hopes to be able to prove that this group is cognate with that of the Austronesian languages, on the strength of points of agreement in the phonetic system, wordformation, and the identily of a number of monosyllabic roots which according to him can be traced in many of the mostly disyllabic „Austronesian" languages. This theory, whose anthropological part has been criticised adversely, was at once praised by H. KERN, but has since then found little sympathy, though it can hardly be said to have been confuted by force of arguments. SCHMIDT's theory is very comprehensive. He points to the fact that there are languages in the Himalaya which indicate that they are cognate with Munda, and he supposes that the ancestors of the Austra-asiatics and Austronesians — he calls them „Austrier's" and the whole of the two cognate groups of languages Austric — were driven bach by Drawidas and afterwards by Aryans: inasmuch as the „Austrier's" just like those invaders who arrived at a later date, are supposed to have come from Central Asia. SCHMIDT's

[1]) Reports of the Royal Acad. of Sciences. Section for literature 3rd Series, vol 4.

conclusion is that Central Asia is the ur-origin of the „Austronesians" and that the Mon Khmer peoples form a link between the two extremes. This thesis which is both attractive and dangerous would have to receive further proofs from various quarters before it can be considered correct.

The same scholar had written an essay in 1899 (Sitzungsber. Acad. der Wiss. Wien, phil. hist. cl. CXLI) on the relationship between the Melanesian and Polynesian languages in which he assumes with Codrington (as KERN had done before him) that the Melanesian languages represent an older type than the Polynesian.

These two groups of languages, very important geographically, but less well developed morphologically and phonetically, will not be discussed in this article, because only that group will be discussed, which in the widest sense of the term is conterminous with the Netherlands East Indian archipelago, Indonesia proper, where (with the exceptions mentioned above) Indonesian languages are spoken. Their principal characteristics may very concise be given us follows:

A. **Phonetically.**

When compared with Sanskrit the character of this group of languages is very simple, especially in the consonant-system. The vowel system is simpler because there are no long and short vowels, as in the case in Sanskrit and Semitic languages, the unaccented e (schĕwa, "Murmervokal"), the a, i, u, (with slight differences in pronunciation caused by the position in open or closed syllables), the e and o in but few varieties and the diphthongs au and ai are the usual sounds. Nasal vowels occur occasionally; a short emission of breath is heard after certain vowels, and especially after those that are essential to the pronunciation of a word or a furtive vowel, notably i and ĕ in final syllables of words in some Sumatran languages. The consonant system also has a simple character. Aspirates occur only in a few languages; fricatives and voiced hissingsounds are limited to but a few idioms; nasals occur everywhere and exercise a predominating influence on consonants following them immediately, especially tenues, whose place is often taken by nasals. Some consonants when final are pronounced imperfectly; several languages have no final voiced consonants (mediae); others have no consonants whatever (the vocalic languages, such as the language of Nias in the West and the Toradja-group in the East); some have a final vowel essential to the pronunciation of a word. No idiom has final palatals. The phonetic system of Melanesian languages is most simple. The number of sounds is small everywhere, unless the two kinds of D and T (supradental and lingual) in Javanese may be looked upon as a remarkable exception.

The language spoken in Nias and the Malegasi language may be mentioned as examples of languages with special sounds, not occurring in other cognate languages. These sounds are: F. Ch, Ndr etc.

B. **Morphologically.**

It is very difficult if not impossible to give a short description of the characteristics of a family of languages. In a few words we can say that just as the Semitic languages are distinguished by the three-radical-system, which might be an extension of the two-radical-system, the group spoken of in this article consists for the greater part of two-syllabic roots which can in most cases be reduced to monosyllabic roots. By these last words we mean that there are groups of more or less synonymous words which have the same root-element. We must state emphatically, however, that by no means all synonymous or almost-synonymous disyllabic words have homogeneous roots. Besides, the theoretical postulate: a language-period of monosyllabic words is not to be realised and older periods as far as they are known present no majority of monosyllabic words when they are compared with modern formations. It is a fact that — supposing the theory to be correct — two-syllabic stems seem to be derived from roots by means of the same formantia as those that occur in the derivation of more-syllabic forms from rootwords. This is the principal point of grammar and at the same time the explanation of the relative poverty of the grammar of these languages, viz: that wordformation is practically almost the only grammatical change their words undergo. There is an extensive system — developed to a considerable extent in the Philippine languages — of adding affixes to wordroots to indicate all relations that Indo-Germanic (Aryan) languages indicate by flexion and conjugation. A consequence of this is a very slight grammatical distinction between the various kinds of words (which for that matter cannot be kept apart like those of the Aryan languages) and an anything but complete conjugation of the verb. When the predicate of the sentence is not formed by adjectives or by forms equivalent to participles, the finite forms occur but in a few cases, viz: where an object undergoes an action, consequently in the case of transitive verbs. Verbs are conjugated by means of proclities derived from personal pronouns, but only few languages have forms for all persons: in some of them it is limited to the 1st and 2nd persons singular.

The restriction of the conjugation to transitive verbs does not seem to be original, but seems to be a remnant of a period in which all verbforms could be conjugated more or less. A slight trace may be found in some languages of a grammatical (not syntactical) indication of time. Some of them indicate time by prefixes, which method is regularly

found in the Philippine languages, in the language of Nias and in Malegasi. Nouns are not declined at all; the only exception is the formation of the plural in some languages. Sometimes words are doubled but this doubling is not so much an indication of the plural as a means to indicate several kinds or varieties of words which are upon the whole felt as collectives rather than singulars. Adjectives undergo no change by degrees of comparison. Comparison is expressed by affixes or infixes. Upon the whole every relation which in (older) Aryan languages is expressed by flexion, is indicated in these languages by agglutination, especially by means of prefixes.

Accumulations of prefixes are frequent in the Philippine languages; when a combination with infixes and suffixes occurs — as in some languages of Celebes — words of unconscionable length may be the result, expressing all kinds of relations between verb, subject and object by means of a series of prefixes, infixes and suffixes. Change of wordroots is only found when such initial consonants as easily undergo the process are nasalised and when some finals vowels change, which process is some cases attended with the appearance of a consonant essential to the pronunciation of the word (as in Javanese). Infixes (especially *in* and *um*) and prefixes occur far more frequently than suffixes. It follows from the preceding paragraphs that the great internal flexional changes of the words in the Aryan languages and the considerable change caused by flexion and soundchanges in the Semitic languages are unknown or exceptional in the area where the languages under discussion are spoken. A good many of them have a strongly marked difference between subjective and objective forms. The first category — used where the subject or the action (which is participial rather than verbal) is more emphatic — is formed by pre-nasalising, in which process the initial consonants (especially the tenues) are absorbed by the nasal. The second category is used when the object is emphatic; this is the so-called „declined form" i.e. the form which has proclitic personal pronouns prefixed to it and which, in many languages, has a passive character. This rule gives to the syntax an extremely simple character, the more so as the wordorder in the sentence does not vary as a rule.

As has been stated above, the scientific study of this family of languages was taken up only a comparatively short time ago. A difficulty in this work is the fact that no older forms of these languages are known. Javanese is the only exception; its older form — formerly called Kawi — in sufficiently known through versions of Sanskrit poems. The historical-philological study of this language has led to excellent results. It goes without saying that the knowledge of older forms of a language is a matter of great importance in comparative philology. It did not get

a scientific character until some important soundlaws were discovered and proved to be true. The name H. N. VAN DER TUUK (the founder of the study of Batak, compiler of the stupendous Old-Javanese-Balinese dictionary and prominent among the students of Malay language and literature) marks an epoch in this branch of science. The study of comparative philology before him, also by scholars well acquainted with one language specially, is nothing but a systemless attempt. Among the Indo-Germanic (Aryan) languages, Slavonic, Germanic, Romance languages can be distinguished and in most cases some ur-types car be found. This is impossible for the languages now under discussion; nor can a genetic table of languages be drawn up. It is possible to give a general survey of the family of languages, which distinguishes as many groups as possible, possessing the same characteristics. As a preliminary observation it may be stated that upon the whole it would seem that a difference may be made between the languages spoken in the Eastern part of the archipelago and those spoken in the Western part of the archipelago. The former must originally have had some relation with the languages of Celebes and the Philippines, however great the points of difference may be at present. Upon the whole it may be said that the Western languages have more suffixes than those spoken in the Eastern half of the Archipelago, which in their turn show a far greater number of prefixes. Pre-nasalising, which in the languages of the Western part serves to indicate the verbal part of the predicate has a special (intensive or frequentative) meaning in the languages of the Eastern part. In each of the two groups some characteristic words occur, which are not found in the other: upon the whole the vocabulary of each of the two groups has some characteristics all its own. The languages of Borneo seem to take up an intermediate position. In some languages the influence of the other group — the one to which they do not belong geographically — is noticeable. It would seem that in this respect the languages of West Sumbawa and Sasak (Lombok) have special characteristics.

A genealogical division of the languages cannot be given, for one thing because there are no data concerning former periods of the languages (except Javanese), for another because nothing is known about the migration of the different peoples and consequently of the history of their languages. Besides the oldest language we know, Old Javanese, has forms which have lost more sounds than more archaically-built languages such as Malay and Batak. The division therefore is mainly geographical but when the languages are divided into groups, another distinction is at the same time made between the groups which have certain characteristic features not found in others. This distinction is not always very

marked; now and then certain groups present features which are decidedly characteristic of others; phonetically there is sometimes a resemblance between languages spoken in parts of the archipelago lying far away from each other, whereas neighbouring idioms may show considerable differences in this respect.

With the proper reserves mentioned above, the following groups may be distinguished.

The Philippine languages, consisting of some fifty languages spoken in the colonies formerly belonging to Spain, but at present under American rule: the Philippine-archipelago. Among these Tagalog has become the most important because it is spoken at Manila, the capital. Some of these languages have characters which can be traced back to Hindoo. Besides these idioms there are dialects of Tagalog spoken by colonists in North Borneo (East coast) and of Mangindanao in the interior of Borneo. The area over which these languages are spoken is bounded by the South of Formosa on the North; the Mariana islands, the Ladrone islands and the Palo islands on the East. The western boundary is west of the Philippines and extends from the extreme south of the isle of Palawan via North Borneo along the Western frontier of Bolaang Mongondow, and in the Tomini-bay it reaches the Southern frontier, which following the East coast of the Minahasa reaches the eastern frontier. It is noteworthy that as early as the 17th century Dutch clergymen studied some of the languages of Formosa for the purpose of bibletranslations and for their confirmation classes. In the Netherlands East Indies the following languages, belong to this group: the so-called Minahasa or sub-Philippine languages one of which is Tontemboan. This language has more forms than the others of the group and it is better known to us than any of these by the grammar and the dictionary written by Adriani (Dr. N.) and Mrs. Adriani—Gunning based on notes made by J. A. F. Schwartz. Other members of this group are the two languages of the Sangi and the Talaut archipelago, of which the former, forms the subject of Adriani's thesis (1893). All these languages are distinguished for a great number of affixes, especially prefixes which may occur in different combinations and thus express all kinds of etymological and syntactical relations. In this respect this group is the best developed type of all Indonesian languages.

The languages of Celebes can be divided as follows:

The Gorontalo group consisting of four languages.
The Tomini group.
The West Toradja-group (Parigi-Kaïli).
The East Toradja-group (Poso-Todjo).
The Loinan group.

The Bungku-Mori-group.

The Muna-Buton-group.

The Makassar-Buginese group; these two languages were studied half a century ago already by the representative of the Dutch Bible Society, Dr. B. F. Matthes, who compiled dictionaries and wrote (not altogether scientific) grammars. These two languages have their own writing characters.

Languages of Borneo. It goes without saying that no short survey can be given of the languages of such a gigantic island. The oldest known is Ngadju-Dyah a grammar of which, (not without merit when we take the time of its appearance [1857] into consideration) was published by a German missionary, Hardeland by name. Vocabularies of other languages, such as Kenja, Kajan, have since then been published; a dictionary of Busang, the language spoken on the banks of the Mahakam appeared in 1910. A survey with short grammatical sketches and wordlists of the languages of British Borneo was made in 1913 by Sidney H. Ray (Serawak Museum Journal, Vol. I).

Sumatra. Acheenese, the language spoken in the North, has a sound-system which differs considerably from that of cognate languages; it has a tendency to cast off grammatical forms. After a first attempt made by a civil service official, this language has been studied scientifically by Dr. C. Snouck Hurgronje. An excellent dictionary of Gajo has been made by Dr. G. A. J. Hazeu. A third language is Batak studied by Dr. H. N. van der Tuuk, who has described the three principal dialects Toba, Dairi and Mandeling in a grammar which marks an epoch in the study of Indonesian languages. Afterwards missionaries studied Karo-Batak successfully. When we compare this language with non-Batak idioms lying round it, we shall find that it is abundant in forms and has writing characters of its own. The language spoken in two different dialects in the isle of Nias is cognate with it, though the sound systems of the two languages differ considerably. Minangkabau — of which two principal dialects exist — resembles Acheenese in its sound-system, but Malay in its stock of words. This language, like Acheenese, is written in Arabic characters, in which Malay is also written. Malay was originally the language of Central East Sumatra (notably Palembang) and the Riow-Lingga Archipelago. It spread to Malacca and became a language of great importance, also on account of its literature. It was used by foreigners in several harbours and settlements and was generally corrupted. The written language of the 17th and 18th centuries has to serve as a basis for the scientific study of the language. The scientific study of its phonetic position in the midst of cognate languages, and the comparative study of its literature are of a quite recent date. Among the students who have applied

themselves to these subjects Dr. VAN DER TUUK must be mentioned in the first place. The language of Simalur is cognate with that of Nias; the speech of Engano and the language spoken in Mentawei have both lost many of their sounds. More to the south are the languages of Bengkulu, Redjang (with writing characters of its own) and a group rather inappropriately called by the name of Central-Malay languages. In the South we find Lampong, studied by VAN DER TUUK.

The languages of Java do not form one class. In Western Java Sundanese is spoken. This language has only a few forms but it is sonorous and has a great aptitude for agglutination. The prevailing language at Batavia and in its surroundings is Malay. This language has been introduced there, it has lost many of its forms and contains a good many words borrowed from other languages, of which the greater part are Javanese and some few Sundanese and Balinese (introduced by slaves from Bali). The language of Central Java is Javanese, the only one of which different periods are known. It has more forms than Malay but in a former period already it was poorer than this language phonetically. The language of former periods, called Kawi at one time, now old-Javanese, is more developed grammatically than present-day Javanese, without, however, attaining the wealth of forms of the Philippine languages. A very great number of Sanskrit words has been introduced into the literary language. Practically nothing is known of the language of the illiterate population. Middle-Javanese is a transition to the modern (literary) language. The modern language shows considerable loss of sound and is much poorer etymologically. The pronunciation has changed, notably a > ā, over a large area and there is a great difference in the kind of words used, depending on the difference in social position and age between the speaker and the person spoken to and of those about whom one speaks. This distinction of "kinds of language" is based on feudal conditions and tabuistic ideas. It comprises all kinds of words so that we can almost speak of two kinds of language: Ngoko or the ordinary everyday speech used among equals and Krāmā or the language used in addressing superiors. Another variety is High-Krāmā, used when speaking about people higher in rank than those present; others are the language used about kings and princes, the dialect spoken in rural regions (Madijā), a more or less variable intermediate form and a nuance of the polite language spoken in certain social circles, and a number of coarse words which, however, are not exclusively Javanese. The characteristic feature of Krāmā is not the introduction of Sanskrit loanwords — of which Ngoko has a good many more — but the language is characterised by the use of quite different terms, other grammatical endings, the use of synonymous words to

replace others which in certain circumstances must not be used, and by the use of other vowels such as *e* and *i* instead of *o* and *u*. The Javanese look upon *e* and *i* as vowels of a superior and more refined nature than *o* and *u*. The whole makes a very artificial, partly tabuistic impression; in spite of the change in social relations the great distinction of the "kinds of language" has kept its ground. This distinction exists also in Sundanese though not so strongly marked and based on different principles and partly derived from the Javanese system probably during the Javanese rule over the Sunda-country. This distinction is characteristic of the languages of Java, to which Madurese also belongs. This language is distinguished for a different sound-system, among other things by the occurrence of aspirata which can only be expressed imperfectly in Javanese characters. Madurese differs from its sister-languages not only in its vowels but also by some grammatical peculiarities. The distinction between different kinds of language occurs also in Balinese, of which language an older form is also known. In the neighbouring isle of Lombok Sasak is spoken. All islands situated more to the east have their own languages; some of them only a few, others have many. Pretty well known are the idioms of Sumba, Birma, Buru, Savu, Ambon (so far as it has not been superseded by Ambon-Malay, used in the church service, which has come to be generally used) etc. Some of these languages belong to the Ambon-group, characteristic features of which are the prefixing of the determining word in genitival groups of nouns; different forms of the personal pronoun (3rd person) to distinguish between words denoting persons and for words not denoting persons; different forms again for the possessive affixes to denote accidental or permanent ownership (which distinction is also found in Celebes and the Melanesian languages). A group of languages distinguished for the addition of anorganic final consonants is that of which Roté (vulgo Rottinese) is the typical representative, viz. Timorese, Kupang, Tettum, Sikka and a few other languages, all of them belonging to the Ambon group. All languages have not yet been described grammatically but there are good vocabularies of a good many of them, giving an adequate idea of the various languages. The languages of the Sula-group and of South Halmaheira are more or less known. The idioms of the Humboldt bay approach those of the eastmost areas, without, however, belonging to the Melanesian tongues. A peculiar Indonesian language is Howa (in Madagascar), whose sound-system more or less resembles that of the language spoken in Nias. It is not known with certainty when and through the medium of what people this language, which contains many Sanskrit words, reached this African island. After Van der Tuuk had given a short description of its grammar, French

scholars have studied it minutely and made it an object of comparison. It must be observed once more that some languages are not Indonesian at all, viz: those of North Halmaheira, Ternate, Tidore, Jalela (where difference in gender is expressed in pronouns and nouns) and the so-called Papuan languages of New Guinea, which differ from each other in various respects. These languages have been studied by missionaries; their relation to other Indonesian idioms has been studied systematically by H. VAN DER VEEN in his thesis (1915). The languages spoken to the east of the New Guinea-area have been partly described in German publications in periodicals such as Anthropos, Archiv für Kolonialsprachen, Mitteilungen aus den Deutschen Schutzgebieten, Zeitschrift für Eingeborensprachen etc.

A survey of Melanesian languages spoken over an area further eastward still is given in R. H. CODRINGTON's "The Melanesian Languages" (1885). This work contains a very long-winded introduction and a discussion of several idioms. Unfortunately it goes back for its discussion of Indonesian languages to the entirely obsolete data provided by WALLACE. These publications as well as the writings of English and French missionaries about Micronesian and Polynesian languages show that these languages are distinguished for a considerable loss of sound, and a tendency to throw off elements, when compared with more archaically constructed Indonesian languages. It is a matter of fact that Melanesian languages[1]) can only be studied historically by comparison with these, but it goes without saying that mistakes cannot be avoided and are indeed made again and again, because, though there are some trustworthy dictionaries, there are also hundreds of non-scientific vocabularies, the use of which can give rise to all kinds of errors when the languages are compared. Many mistakes for example were made when Melanesian and South American languages were compared with each other. The stock of words of all these languages has a homogeneous character in some respects, especially the numerals, the system of possessive suffixes is upon the whole the same, but phonetically there are great differences and the addition of enclitica to verb-roots, to indicate the various persons, is far from uniform.

In the preceding pages names of students have on purpose been mentioned only exceptionally. All kinds of articles about the many languages of the Dutch East Indies written by people more or less qualified for the task, have appeared in all kinds of periodicals; they also made vocabularies or wrote grammars. It is practically impossible to

[1]) S. H. RAY, A comparative study of the Melanesian island languages, Cambridge, 1926 is, of course, more up to date and methodical than CODRINGTON's work could be.

mention them all; besides, this survey is no bibliography and it is not the author's intention to write anything like it. It has been mentioned above that the first people to study any of these languages were missionaries. After them philologers took up the subject occasionally and proceeded to make a scientific study of what had been collected by non-experts. Civil-service officials, too, have often made a study of several languages, in most cases for practical purposes, and their work has afterwards been studied more systematically by philologers. In the Netherlands East Indies there is no department for linguistic research financed by the government, like the Linguistic Survey of India. This can hardly be called the fault of the government, because the staff of experts to study the languages of an archipelago consisting of some gigantic islands, several smaller ones and a host of small isles, would cost no end of money. Far less than in British India would it be possible to leave this work to natives in the Netherlands East Indies. The government in the Dutch East Indies has done much for linguistic research. In 1877 an official for the study of Indian languages was appointed; at the time Holland was the only country in the world that had an official for this sort of work. It is true that the office has not been held by many persons and it must also be admitted that the results obtained have not always come up to the expectations, yet if we consider what has been done by some in the service of the government — we mention only H. N. VAN DER TUUK for Malay, Old Javanese, and Balinese; A. B. COHEN STUART and R. FRIEDERICH for Old Javanese; H. VAN DE WALL for Malay; J. L. A. BRANDES for Old Javanese and Presentday Javanese; C. J. G. JONKER for Bimanese, Roté (vulgo Rottinese) and other eastern languages; C. SNOUCK HURGRONJE for Acheenese (a study the more remarkable as his official duties took up practically all his time); G. A. J. HAZEU for Gajo, — and when we bear in mind that the government has defrayed the entire cost of a good many publications or lent financial assistance to others, we shall come to the conclusion that there is every reason to be grateful for what it has done for this work, most times of an ideal nature and never at any time remunerative financially.

Men like H. N. VAN DER TUUK for Batak; B. F. MATTHES for Buginese and Makassar; N. ADRIANI for the languages of Central Celebes, notably Barée, have done bibletranslatorswork but have also received the support of the government. H. H. JUYNBOLL, a student of Old Javanese, who had given evidence of his knowledge of Old Javanese in periodicals and in books published by scientific societies, published a dictionary of this language (1923) entirely at the expense of the government. Other dictionaries (Batak, Sundanese, Busang, etc.) for which government-

grants were obtained will not be mentioned in these pages. When we make a survey of the vocabularies, dictionaries and grammars of Indonesian languages, we shall find that a great many of such works have been published, that now and again the knowledge of compilers and authors was inadequate, but that some eminent scholars have achieved great things. There are names which will be for ever remembered in the history of the study of some languages. Among them are T. ROORDA for the study of Javanese. ROORDA, who was wellknown already as a writer of a Hebrew and Arabic grammar, has also made a name for himself by a grammatical study of Javanese. In his study of etymology and in his comparison between Javanese and Malay-words he failed and was influenced by the fantastic theories of his time, which were confuted once for all by H. N. VAN DER TUUK. This scholar, who was the first to make a thorough study of Batak, and a diligent student of Malay, who edited and published VON DE WALL's dictionary, who had an extensive knowledge of Old Javanese — of which language he compiled a very bulky dictionary (unfit for practical purposes on account of its size) — was the man who put an end to the philological chaos by establishing some sound laws for the Indonesian languages generally, which have led to a phonetic classification of these idioms. The discovery of these soundlaws has become the turning-point in the study of Indonesian languages. VAN DER TUUK's laws are applied whenever new groups are studied, both to identify the language in question and to establish its relationship with cognate languages. J. L. A. BRANDES made a systematic study of this subject in his thesis (1884), a work which promised much. This promise has not been fulfilled, however, because this scholar afterwards applied himself to the study of Old- and New Javanese, Javanese archaeology and epigraphy. H. KERN makes use of these soundlaws, at least to a certain extent, in his epoch-making work: Fiji, compared with its cognate languages in Indonesia and Polynesia (1886). Though this work — as has been made clear already — may contain much that is untenable, though the author takes too much for granted or goes too far on the subject of etymology, however this may be, it has the lasting merit of being a systematic work showing an extensive knowledge of languages by which [more than by his later work on the position of Aneityum (1906)] the sanskritist KERN, afterwards the eminent student of Old Javanese, has won for himself a place of abiding fame among all students who have applied themselves to the comparison between Indonesian and Polynesian languages. If, however, one wishes to have absolute certainty in making the comparison, it is necessary to know all facts and circumstances; this is found in N. ADRIANI's work for a group of languages of Central Celebes. A few words

may here be said about it. The work we mean is the third volume of Dr. N. ADRIANI and Dr. A. C. KRUYT's "Barée and the Toradjas of Central Celebes; a sketch of the language and literature of Barée and a survey of the area of the languages spoken in Celebes and South-Halmaheira", published at Batavia (1914) and printed at the expense of the government (this part was written by Dr. ADRIANI). The language studied is here compared with all cognate languages so that there is no room for etymological speculation or conjectural etymology. In this way only can the characteristics of a certain group of languages be described and established. If various groups of languages were studied in this way the result might be a general detailed comparative description, possibly even a genetical synopsis of Indonesian languages. When we bear in mind that Dr. ADRIANI held no post in the civil service and could devote all his time to his linguistic studies and when we also bear in mind that this investigator worked a number of years before he could write a work like this, it will be clear that it is impossible to publish a comparative survey of the languages of the Dutch East Indies in a few years, even though quite a staff of experts should be available for the task. What VAN DER TUUK has done for the three Batak idioms and ADRIANI for the languages of Central Celebes, would have to be done by an equally competent staff of investigators (with no other task before them) for the languages of Borneo, the lesser Sunde islands, and all other groups; but in such an extensive area, with such an astounding number of languages, where sometimes (as in the case of Halmaheira and New Guinea) every village has a separate language, such a survey would take up an endless number of years.

New languages are described again and again, especially by missionaries and by the very small number of government officials who can find time for the work; sometimes also by Dutch or foreign scholars who have not made this branch of science the aim of their life; various periodicals often contain sketches, sometimes complete grammars and vocabularies of languages hitherto altogether or practically unknown. As a rule such publications are useful to those who have their daily occupation in the regions where such languages are spoken, and they are nearly always of some importance for the comparison of the various languages. Periodicals like those of the Kon. Instituut voor de Taal- Land- en Volkenkunde van Ned.-Indië and of the Kon. Bataviaasch Genootschap van Kunsten en Wetenschappen and of the combined mission-societies give sources for the knowledge of languages and data for the comparison between them in almost all yearly volumes. Practically every volume of the proceedings of the society just mentioned contains articles about new languages that have been studied, helpful for practical and scientific purposes. When only

scientific purposes are taken into consideration, phonetic completeness and etymological accuracy, in a word linguistic competence must be required for the description of every language; it is necessary to inquire which of the universal soundlaws — pepet-law, R-G-H-law, R-D-L-law, which have been so methodically and accurately set forth by the Swiss philologer R. BRANDSTETTER in his monographs on Indonesian questions — exercise influence on it, and to find out whether there are any deviations from those laws, what differences there are in this respect between the language in question and others, closely and less closely related to it. It is a source of great joy that especially of late years excellent descriptions of several languages have appeared. It goes without saying that the survey of the division of the different languages with respect to the various criteria, such as vocalic or non-vocalic word-ending, loss of initial consonants, possible accumulation of affixes and such like, becomes more and more comprehensive whenever new groups of languages are studied. The perspectives of this branch of learning are wellnigh endless. The study of Indonesian languages has a bright future before it when the missionaries with their numerous essays which have done signal service to science, work on side by side with well-trained philologers, who make the discoveries, write the descriptions and arrange the materials. There are but few of those scientifically trained labourers and though it is easy to find an explanation for this, it is not to be expected that their number will increase considerably for some time to come; for all that it would seem that gradually some progress is made.

All that has been said about the study of the languages holds good also for the study of their literature. Hardly any time has been devoted to the literary history of Indonesian languages. As a rule philology and literary history were studied together. Of late years, however, serious attention has been paid to problems of literary history, to the comparative study of the literature, to the comparison of productions of Indonesian literature with each other and with analoga in India and Farther India. This work has been undertaken in connection with the gradual extension of the study of the various peoples in all their manifestations. The literature of Malay was studied first. As early as the 18th century VALENTYN and WERNDLY gave a list of Malay writings with which they were acquainted. Afterwards stories and volumes of moral tales were published, mostly based on one manuscript and with hardly any criticism. The survey of the whole of Malay literature was not completed before the existing collections of manuscripts were catalogued methodically. Then it was also possible to indicate what had been borrowed from Arabic and Persian sources, what had been adopted from Javanese, of what works the prototypes were to be found

in India and what could really be called original, popular Malay literature. It appeared that what was really original was very little in comparison with the many foreign elements. The study of Javanese literature was taken up at a later date. This work was more intricate because of the existence of two periods (Old Javanese, formerly called Kawi) and modern Javanese, separated by a link Middle Javanese, which is hard to define. The first works were imperfect publications; they were followed by contributions showing a more thorough knowledge of the subject and presently very good essays on special parts of Javanese literature appeared. It is impossible to mention here the names of all who have studied the subject; VAN DER TUUK, KERN, BRANDES, JUYNBOLL have acquired a great reputation. The literature of modern Javanese i.e. the production of literary works by native authors has reached a far higher degree of development than Malay literature. No complete description of all existing Javanese manuscripts has been published yet and there is no doubt that in future various productions of Javanese literature of different kinds and epochs will be diligently studied. As a matter of fact some writings about this subject have appeared of late years. Formerly texts were published at haphazard; there was no criticism and nobody troubled about the taste of the Javanese readers. This became much better when the works of the modern Javanese authors were printed. Another improvement is the publication, by a scientific society, of a number of works which in a way may be looked upon as classics. The committee for popular literature has also achieved great things. Sundanese has hardly any literature worth mentioning and there is little variation. Much of it has been collected in anthologies; several stories have been published; novels and epic poems belonging to the earlier literature have appeared in print and owing to the good offices of the committee for popular literature many Sundanese authors have found an opportunity to get their works printed. Several of these are very nice and interesting. Not a few works in Madurese have been published in separate editions and in anthologies but catalogues of manuscripts show that many more than these have been produced.

In Sumatra the state of things is quite different. Malay has already been mentioned as a Sumatran language, which however, is hardly recognised as such any more. H. N. VAN DER TUUK has more than any one else made the world acquainted with the literature of the Sumatran peoples for he made a profound study of Batak and published part of his great collections in his Batak reader, a work of three volumes. The texts in these volumes have been taken from the Toba, Dairi and Mandeling districts. Publications of Batak texts from other districts did not follow until a good many years after that time.

The literature in question so far as it does not consist of works about astrology, containing charms, incantations and other astrological matters, is composed of stories, most of which are of native origin; some have been borrowed from neighbour countries and many others again are found all over Indonesia, even in India. A critical study of all these popular tales is given in Dr. P. VOORHOEVE's thesis (1927). Acheenese literature — almost entirely poetry — has been collected in manuscript. Dr. C. SNOUCK HURGRONJE has published abstracts of these poems in vol. II of his famous work "De Atjehers" (The Acheenese), but for the rest hardly any Acheenese poems have been published. It is to be expected that many a study will be devoted to specimens of this literature and its relations to Malay literature. Of Minangkabauw literature more has been published; it consists for the greater part of long poems, which contain a good many remarkable things about the older periods of civilization. The present generation has lost interest in these longwinded poems, which according to the modern taste are very monotonous.

Enough has been published of the older writings to give us an idea of the popular national literature of bygone days. It goes without saying, however, that every serious publication of this category will be heartily welcome. The literary productions of the other parts of this large island — so far as they are known — consist in the main of stories, tales and fables, especially beast fables, among which the stories about deerlets must be mentioned in the first place. Of these works, too, enough has been published to give us an idea of the genre; but of course every addition to it will be welcome because it may serve to make us better acquainted with the character of the national literature and enable us to compare it with analogous elements of other Indonesian literatures and other collections of Asiatic stories. A few works of the literature of the literate population of Bali (a remarkable island in many respects) have been published and a pretty complete survey of this literature exists. The older form of the language has come down to us through interlinear translations of old Javanese poems. The later and more modern literature of this island is better known to us than that of former periods. B. F. MATTHES has published a good deal of Buginese and Makassar literature in his chrestomathies; though we must be grateful for these contributions it cannot be denied that the number of Mohammedan writings they contain, is rather too great in comparison with real native productions. However, we should not be too critical here, because for a considerable time manuscripts were the principal source of information for the compiler and in his days contact with that part of the native population which did not live in the capital was far from easy. Part of the literature of several islands has been published. These

works — tales and stories for the greater part — are mostly poems. When they are preceded by sketches of the grammar, these works are valuable documents for those who wish to learn the language and for those students who wish to study the traditional legends, stories and tales of the various peoples, a subject, which taken up a few years ago begins more and more to attract the attention of students. It stands to reason that every contribution to the stock of stories and tales will be welcome. It will be difficult if not impossible to render greater services to philology and folklore than was done by the authors of the work about the Toradjas speaking Barée. This work makes us acquainted not only with the whole of the existing literature (of a people that knows no alphabetical writing) but also with the national ideas about literary utterances of the human mind, the place which they occupy in social and inner life, the appreciation of poets and storytellers, in short the ethnological meaning of wordcraft and the study of style. This is a new point: the study of literature as an ethnological-folkloristic element: prohibitive regulations, ritual actions, sacred customs and such like in connection with the writing and reciting of national sacred songs. Here, to a certain extent, lies the origin of Indonesian literature so far as it has remained national and has not been corrupted by Islamitic influences or attempts at learned "Schriftstellerei", as in Malay. Alphabetical writing will no doubt be a factor contributing to denaturalization and refinement, which is not found among the peoples who do not know the art of writing, who recite everything by heart and need not pay so much attention to form. „Littera scripta manet" holds good also in this case; the sense that what has been committed to paper cannot be changed may lead to greater exertion in writing and consequently to unnaturalness and hyperstylistics. Of course this does not hold good for historical and more or less scientific works, so many of which exist in Malay and Javanese. Many important articles and books have been written about the former and it is to be expected that a good-deal will be written about it in future. In these investigations a comparison is mostly made between analogous productions in the two literatures, which is of great importance to literary history. Much work remains to be done still in this department. H. N. VAN DER TUUK and J. BRANDES were the first to take up the subject, they have been successfully followed by several younger scholars. The foreign elements — Persian and Arabic in Malay stories and Hindoo elements in Javanese tales — attracted attention for a long time and led to interesting studies. Of late years, however, productions of Indonesian literature have been studied more and more as utterances of a national literary impulse, consequently with a view to find out their own merits. As the study of groups of langu-

ages hitherto known only from vocabularies increases and if the mostly unwritten literature of these languages is studied at the same time, both the study of comparative literature and that of literature as an utterance of the Indonesian mind will make constant progress. Fortunately there are signs which point to an increasing scientific interest in this subject, which may lead to excellent results if the government does not withhold its indispensable support.

# ETHNOGRAPHY AND DEMOGRAPHY

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## SECTION I.

In the Review of the Ethnological Investigations in the Netherlands Indian Archipelago, composed for the Circumpacific Scientific Conference in Australia (1923), an outline has already been given of the results which these investigations produced with reference to the different Ethnical groups, dwelling in the Netherlands Indian Archipelago. There would be no point in repeating these results here, and the subject which now seems to present itself for discussion is one around which a number of ethnographic, sociographic and demographic details are grouped, which give an idea of the relations on the Island of Java and on the smaller island of Madura (which ethnologically and for administration purposes forms part of the former) in connection with those on other islands of the Netherlands Indian Archipelago. This subject, which is of importance for the whole Pacific, bears upon the circumstances and the government regulations which either promote or hinder the development of the native population in the Netherlands Indies; it is therefore closely related to the results of the researches made into different spheres of Ethnography, in as far as they practically culminate in the problems concerning the density of population and correlative problems: the growth or decrease of the population, and the geographical, social, political and economic relations in which one lives or used to live.

The Netherlands Indian Archipelago offers in this respect a favourable field for investigation, as the census of the natives is now known with an accuracy which makes it possible to draw conclusions in some respects, and moreover, because demographically extraordinary differences are noticed within the archipelago, which demand an explanation, and which therefore stimulate to further research. In order to make it clear which is the question here, one is reminded that we mean by Netherlands Indian Archipelago that part of Indonesian Austronesia which is governed by the Dutch. This Archipelago, inhabited by about fifty million natives, consists therefore of Indonesia without the continental portion, without Formosa, the Philippine Islands and Madagascar, but it includes New Guinea. The non-Netherland portions of the last-named island, of Borneo and of Timor will not be considered below.

The Archipelago thus defined lies approximately between 6° N.L.

and 11° S.L. and between 95°—141° longitude east of Greenwich, and comprises a land surface six times as large as Great Britain and Ireland, or fifty-eight times as large as Holland. It is inhabited by a very large number of ethnical groups and sub-groups, of which the principal are:

I. In and near Java: The Sundanese; the Javanese; the eastern Javanese with the Madurese.

II. In and near Sumatra: The Achehnese; the Gajo and Alas; the Bataks; the Menang Kabau Malay; the Malay of the East Coast and the Riau Archipelago; the Southern Sumatrans; the inhabitants of the islands to the West and the East of Sumatra.

III. In Borneo: the native tribes of Borneo (Dyaks).

IV. In and near Celebes: the inhabitants of Northern Celebes; those of Central Celebes (Toradja); the Macassar people and the Bugis.

V. In the Moluccas; the Papuans of New Guinea and the surrounding islands; the inhabitants of the Southern (Amboina) Moluccas; those of the Northern (Ternate) Moluccas.

VI. To the East of Java: the Balinese; the inhabitants of the other „Small Sunda Islands"; the inhabitants of the Timor-group.

When we consider on the strength of the census held in 1920 — which took place in the different administrative units, and which still serves as a firm basis and definite startingpoint, although it has since been amplified by administrative census — how things are with reference to the density of population in the different geographical units, as indicated in the above list, we come to the following figures: [1])

| | Area in km². | Natives. | Per km². |
|---|---|---|---|
| I. In and near Java ..... | 131.441 | 34.433.476 | 262. |
| II. In and near Sumatra ..... | 471.551 | 5.953.250 | 12.6 |
| III. In Borneo ..... | 535.638 | 1.533.798 | 2.9 |
| IV. In Celebes ..... | 188.240 | 3.075.108 | 16.3 |
| V. In the Moluccas (with New Guinea) ..... | 498.455 | 612.126 | 1.2 |
| VI. To the East of Java ..... | 74.827 | 2.696.862 | 36. |
| Netherlands Indies ..... | 1.900.152 | 48.304.620 | 25.4 |
| In and near Java..... | 131.441 | 34.433.476 | 262. |
| Outside Java ..... | 1.768.711 | 13.871.144 | 7.3 |

[1]) Statistisch Jaaroverzicht van Ned.-Indië, 1926. After the census of 1920 the resulfs of later census became known, but it seems advisable to take only the census of 1920 as a basis for considerations.

Here two things are striking: 1°. a very great density of population in Java and Madura; 2°. a sparse population outside these two islands. A third remark can be made on analysing the above figures, viz: that the densely populated areas of these regions outside Java, namely the islands Bali and Lombok, which are situated directly East of Java, show densities which correspond with the least populated areas of Java, this being also the case with a single region at the West Coast of Sumatra (Priaman). But for the rest a marked difference. The density of population of Java (with Madura) is very striking and amounted in 1920 to 262 per km² (in 1925 estimated on 272 per km²) against 7.3 per km² (in 1925 estimated upon 7.4) in the remaining part of the Netherlands Indies. Is this density of population in Java, compared with other parts of the world, to be called remarkable? Yes, of course! This density of population considerably surpasses that of densely populated Bengal and those of the most densely populated areas of China and Japan. The density of population of Java (here 35 million people live on an area equal to ¼ of France) only occurs in the most highly developed industrial centra of Europe: Saxony, Rhineland, Belgium. *Java has the greatest concentrated density of population of all the agricultural peoples of the Earth.* And beside, densities of populations occur on the neighbouring islands, also under Dutch Government, which may be called exceptionally sparse (sometimes 10—20, or 5—10, and even 2 people a km²).

If it therefore appears that the density of population of Java can be called considerable also in comparison with other regions of the world, the growth of population on the island shows interesting figures too. It is a good thing not to go back too far in this respect when comparing figures, because in the first half of the 19th century the method of taking a census was by no means so accurate as to justify the making of reliable comparisons. In general it can be said that the accuracy of the demographic figures has increased in the course of years, and that the most recent results of the census are nearest to the truth. This must be well kept in view in all the following considerations, for a rise from 10 million to 35 million in three quarters of a century is enormous indeed.

The rates of density for Java and Madura are as follows

1860: 94 a km² (less than the density of Bantam now)
1870: 124 „ „ (the density of West-Priangan now)
1880: 149 „ „ (the density of Besuki, Bali and Lombok now).
1890: 180 „ „ (less than the density of East Priangan now.)
1900: 216 „ „ (less than the density of Indramaju now and more than that of the Netherlands.)
1905: 228 „ „ (the density of Buitenzorg now)

Accumulation of settlements aloug the base of the volcano Muria (in the North of Central Java).

Accumulation of settlements in the South Eastern part of the Kedu-plain.

Adjoining settlements in the fertile plain behind the sand dunes of the South coast of Central Java.

1917: 256 a km² (the density of Central Priangan now)
1920: 262 „ „ „ „ „ „ „ „
1925: 272 „ „ (about the density of Madiun now)

Differently expressed the growth of population in periods of 15 years is:

| | |
|---|---|
| 1860—1875 | 52 % |
| 1875—1890 | 31 % |
| 1890—1905 | 26 % |
| 1905—1920 | 17 % |
| 1910—1925 | 13.6 % |

Even if these figures should need some correction, because former census were less exact than the later ones, at any rate there appears to have existed, and still to exist in Java, a very considerable growth of population, although the rate of growth is decreasing automatically in the course of years [1]). This considerable increase in population is especially noticeable compared on the one hand with the fairly stationary number of the population of other islands, and on the other hand with the declining numbers of some regions in the Dutch Indian Archipelago.

SECTION II.

Wherever a decline in the number of inhabitants is noticed in the Pacific, one thinks in the first place of the contact with European-American culture. In order to maintain themselves the poor in culture must take far more than they give, for a lower level of culture means less power of resistance and a sparse population, whenever the latter has not been raised by influences from outside, which bring civilization and prosperity, by taking away the obstacles which prevent growth of population with the less civilized peoples [2]).

[1]) For the above mentioned figures see in the main: J. VAN GELDEREN. Het bevolkingsvraagstuk op Java, 7de koloniale vacantiecursus voor geografen (1926), p. 25, or Indische Mercuur 16 Maart 1927. The same author: Voorlezingen over Tropisch koloniale Staathuishoudkunde 1927, p. 74 s.s. See as well: J. VAN GELDEREN. Bevolkingsdichtheid en landbouw op Java. Koloniale Studiën 1922. For the connection between welfare and spiritual development see: Het Verslag van de economische toestand der Inlandsche bevolking. 1924. Deel I. p. 362.

[2]) SAPPER. Die Bedrohung des Bestandes der Naturvölker und die Vernichtung der Eigenart. Archiv für Rassen- und Gesellschaftsbiologie. 1917. S. 268 ff.

See as well: RATZEL, Anthropogeographie 1891. II. S. 253 ff. and The fate of primitive man in: The Geographical Review. May 1916. p. 379. Specially: S. H. ROBERTS. Population Problems in the Pacific 1927 and LANE FOX. The clash of Culture and the contact of Races. 1927.

Here we are arrived at the very problem of acculturation, the sins of which one is prone to measure by what happened in Australia [1]), Tasmania [2]), Oceania [3]). It is not the place here to enlarge upon this subject, but VAN GOHR's words [4]) seem to the point, when he says with reference to the populations of the French and of the Belgian Congo: "The conservation of the Native populations does not only present a medical side. It is equally, and perhaps before all, determined by the politics of the governments."

The decline of the population is also known in the Dutch Indian Archipelago, even if only as a local phenomenon on a small scale. It was recorded in the little island of Enggano, West of Sumatra, where owing to decreasing birthrate and all kinds of diseases the native population was disappearing, and only was saved by measures taken by the Government and by the Protestant mission; in Buru, where during many years a small decline in the number of inhabitants seems to have been noticed, as a consequence of some infectious diseases and all kinds of wrong morals; in West-Ceram, where the population is supposed also to be deteriorating through the same causes; and in Southern-New Guinea, where barbaric demoralization, tremendous infant mortality as a consequence of nomadic living, and disease, imported by foreign inferior adventurers, caused ravages, but where, through measures applied by the government and by the Roman Catholic mission the deterioration seems to have been brought to a stand-still.

But, as was said before, these are local facts, which regard only a few thousands, which are therefore of relatively small signification in proportion to the fifty million other Dutch Indian subjects, the more, as on all islands except Java and Madura, taken as a whole, a fairly stationary number of population may be fixed, with perhaps an inclination towards an increase in the number of the population.

But alongside and against the background of conditions, which may be considered fairly uniform in this respect on the big islands of the

[1]) B. v. SCHULTZE. Das Aussterben der Australischen Bevölkerung. Arch. f. Rassen u. Gesellschaftsbiologie. 1913. S. 93 ff.

[2]) Summarized by SUTHERLAND. The origin and growth of moral instinct, 1898. I. p. 122. See „Algemeen Zondenregister" by DE LANESSAN. Principes de colonisation, 1897. p. 49, and HERMAN TEN KATE in Indische Gids. Juni Juli 1916. I. p. 701, II p. 861. See as well: KÜLZ and PRINZING. Arch. f. Rassen- und Gesellschafsbiologie. 1910. S. 533, 579.

[3]) CAILLOT. Les Polynésiens orientaux au contact de la civilisation. 1909. RIVERS. Essays on the depopulation of Melanesia 1922. HERMAN TEN KATE. Tijdschrift Kon. Ned. Aardrijkskundig Genootschap. 1894. p. 772, 795.

[4]) A. VAN GOHR. Des remèdes à apporter à la dépopulation des Indigènes dans les colonies équatoriales de l'Afrique. 1921.

possessions outside Java, the conditions in Java and Madura stand out as remarkable facts, which draw the attention in two ways:

1°. by the all surpassing density of population in this tropical agricultural island;
2°. by the very rapid growth of population during these last three quarters of a century.

These facts may for a great part be explained by the geographic and geophysic environment.

Similar geographical and geophysical circumstances as in Java and Madura are only to be found on the islands of Bali and Lombok, situated East of Java, and there the density of population is consequently equal to that of the Eastern provinces of Java. But elsewhere in the different big islands there are vast, almost inaccessible mountaineous regions, or regions abounding in water, which the natives could not make use of for their food provision. In other places the circumstances for the cultivations-methods, which of old have been applied by the population for their food provision (rice), are less suitable or the soil is less fertile than in Java. Or elsewhere the land may be so rocky and dry that there never will be a question of prosperity of large groups of population.

Java however has been since many centuries an old agrarian country, thanks to the volcanic nature of the land and the abundance of river water which can easily be made use of for the irrigation of the rice fields; this appears from the fact that only 24.4 % of the total surface of Java is not being used for agrarian purposes, because it consists of volcanoes, rivers, swamps, towns, villages, roads. But 55 % of the surface of the island is arable land of the population, 17.5 % consists of forests and 3.1 % is being used for European agriculture.

By degrees the natives have extended[1]) their agriculture over all areas within reach, and they have also intensified it (by applying irrigation to ricefields where formerly the rice was cultivated on dry land). In consequence the area of rice-field available per head of the population has remained more or less stationary during the last years, notwithstanding the great increase in population.

Yet there is a considerable yearly importation of rice; besides, cassava, maize and batata are gradually becoming popular articles of food. The geographic and geophysic nature of Java was the cause that a general and fairly even degree of prosperity prevails throughout the whole island. Owing to geographic conditions it is necessary, when

[1]) Where in Java difficulties of the area, which cannot be conquered by the native population, are conquered by Western means, a move of the population thither can be immediately stated.

Javanese market near Malang.

Market for coco-nust in Java.

dealing with problems arising from the results of the census, to handle these results grouped as much as possible according to geographic-geophysic units, and not according to administrative units, which often have been fixed without taking ethnical-geographic factors into consideration, as they are to be found in the separate islands or island complexes.

If one does this, the list of the population-densities in the four large islands will be as follows:

| | | | |
|---|---|---|---|
| A. Java | density | 262 | inhabitants a km² |
| B. Celebes | „ | 16.3 | „ „ „ |
| C. Sumatra | „ | 12.6 | „ „ „ |
| D. Borneo | „ | 2.9 | „ „ „ |

We then see that Java distinguishes itself from the other islands by:

1°. Its fairly general fertile new-volcanic formation with vast areas, suitable for the cultivation of the food-plants for the Natives.
2°. Rivers, which the Natives know themselves how to manage and utilize, and which generally have a gradual fall, and are mostly deeply cut into the soil.
3°. Terraces, which descend fairly gradually from the central range of mountains to the coast, and which can be irrigated by the natives from those rivers.
4°. Regular monsoons, which at definite times regulate the agricultural calendar and ensure the cultivation of water-needing plants, or of those which can grow without water.
5°. A country, which through its formation has been opened up for inland traffic and communication ever since the period of native rule.
6°. The absence of the great difficulties of communication which are found in the other islands, where the Natives are unable to cope with the evils of high water in the great rivers and of the flooded forests along these rivers.

It is evident that in all these respects Java is favoured above the three other islands. For where these factors also count (Bali) the density of population is similar, and in Java itself the density of population varies with these factors, a smaller density of population being found on the lime-formations and a greater density of population in the new-volcanic plains with the large rivers of Central and East Java, which show more than 500 inhabitants a km². However, these geographic conditions can only partly explain a possible density of population, and therefore in some respects also the rapid growth of population. It would, indeed, testify

to an imperfect method, if the historic, the social and the political factors too were not considered in the research into the demographic particulars, especially where these indicate an exceptional increase in the number of the inhabitants of Java and Madura.

SECTION III.

Before examining in how far these factors are working more favourably or less favourably in Java than in other islands of the Indian Archipelago, it is necessary to get an insight into the birth-rate of the Indonesian peoples. This birth rate is generally high, in spite of endemic malaria and hook worm disease (ankylostomiasis), and the factor of the high birth rate enforces itself the more, because all individuals play a part in the process of propagation. Nobody remains unmarried, nearly all women marry several times (after previous divorce, of which childlessness may be the cause), the social increasing apparatus works completely, even if impaired by obstacles, of which more will be said later on. How high then is the birth rate? For the Tanimbar islands nearly five children to every woman; in Central Celebes and in Central Sumatra four children to every woman; with respect to Borneo even as much as an average of 8 to 9 children to every woman is recorded. In Northern Sumatra an average of 47 children is born per annum to every 1000 inhabitants, a number which corresponds to that of Russia before the revolution (Netherland in 1876: 37, in 1925: 24). And so the birth rate for Java can be safely estimated on about 40 per annum to every 1000 inhabitants.[1])

In such (Indonesian or Slavonian) as well as in all other societies the problem with reference to the desired growth of population lies in this: that the relatively high birth rate as a factor for the density of population be maintained and not be lost again: in other words, that the birth surplus be as much as possible maintained. A general remark may here precede the discussion of measures which can help to bring this about. The connection between the density of population and the

[1]) A. H. P. A. Scheltema. De groei van Java's bevolking, in: Koloniale Studiën. 1926. p. 866, estimates the birth rate in Java and in Madura from 1885—1895 on 35.1 $^0/_{00}$, from 1915—1923 on 29.2 $^0/_{00}$, but these figures are probably too low in connection with what is known of British India, Ceylon and Japan.

Dr. M. Straub. Kindersterfte ter Oostkust van Sumatra, 1927, speaks repeatedly of the great fecundity of the Javanese woman, who on an average gives birth to 5.1 children. With the kulie women on some tobacco plantations the birth rate was 41.9 $^0/_{00}$, even though one cannot speak here of a natural community of natives (page 27). Although the infant mortality is great with the Javanese, such fecundity still allows of a considerable birth surplus. „As far as man is concerned there exists a prodigality of life in the tropics;.... the native of the tropics is able to maintain his state only by means of an abundance of children". (Straub p. 32).

*level of civilization* reached by a group of people, mainly becomes evident when there is a certain amount of economic welfare. For a certain welfare can go hand in hand with more or less hygienic care; a certain civilization with cleanliness, suitable houses, clothes, food, etc.

Uncivilized peoples are weaker in their surroundings by lack of insight in the realities of life; they therefore catch diseases more easily, they are labile in case of epidemics. A lack of technic, a shortage of methodical thinking, a shortage of will-power renders them inferior in the struggle for life in the midst of their natural surroundings. The faulty conceptions and expedients which are associated with their low development, their wrongmorals, their mutual quarrels, these all work together as a hindrance in the rise of the population.

So the task of a Colonizing Power should be in the first place to take care that a general welfare and a certain level of civilization prevail in the oversea's dominion. Both are only to be attained on the basis of a well regulated Government, which looks after interior rest and security. Only with absolute peace in the country, roads for communication, extensive and intensive agriculture and industry, education, hygiene and all other government regulations in behalf of the welfare and the happiness of the population can appear to full advantage. And so possibilities are called into existence for a higher culture and a higher number of population. A higher number, which can exercise more influence in its sphere and which gives a greater chance of leaders.

The first condition is rest and security in the dwellings of the people: where these prevail nomadic life is out of the question — people stay with the goods acquired by work: house, fields, cattle, etc.

This is the great advantage above native communities which are left to themselves, in which hostility among the different tribes brings with it continuous unrest, insecurity, vengeance and revenge. There is nothing which is so detrimental to the prosperity of such communities as that unrest, when the men leave their homes, when people wander from place to place, loosening their ties with the group and so enfeebling with respect to its morals and its customs.

When anywhere there is a question of a decline in the number of the population, or of the extinction of groups of people, one should first of all inquire into the factors which cause unrest, insecurity, emigration, "trekking" of the men.

It is said sometimes that the population of Java has become nine times as numerous in 100 years. This statement is exaggerated, because the number of the population of a century ago is put too low. But yet we can safely say that the population of Java has been multiplied several times in a century.

Javanese mother.

*The principal cause of this is that Java*, where Dutch influence made itself increasingly felt from the beginning of the 17th century until the beginning of the 19th century, *has been enjoying a period of undisturbed peace* under the Dutch Government during these last hundred years. Of which other country can this be said? It is the *Pax Neerlandica* ruling over this people and in this geographic and economic centre, which has caused the rapid growth of the Javanese population. But it must be said, that, regarded from a historical point of view the Dutch could work in favourable circumstances, because before their appearance Java had already intensively undergone two other cultural influences. For there were, apart from the Chinese contact, three great streams of culture from the West: the Hindu, the Mohammedan and the Christian, or in other words: the Pre-Mohammedan-Hindustani, the Mohammedan-British-Indian and the West-European.

These three civilizations were brought to the Indies with the articles of trade in the ships by the Straits of Malacca, which joined Rome and China, Europe and Southern Asia. For the merchants, who came to get the valuable spices from the Moluccas, were at the same time the bringers of new social institutions, art and religion With the civilization brought from British India the Native civilization soon became harmoniously one in many ways: government, public worship, literature, stage, etc. The Hindu civilization from South-Eastern-British-India made a Hindu-land of Java, as early as the fifth century, and in the seventh century Central Java was already thoroughly Hindu-Javanese, while centra of Hindu-rule were also established in Southern Sumatra and in other parts of Southern Asia, Annam and Cambodja. But by degrees Java becomes the centre, from where the Indian Archipelago is governed, and in the 14th century the Hindu-Javanese Kingdom of Madjapahit under King Hayam-Wuruk has the supremacy over the whole Archipelago. This to be the course of history, for in economic-geographic sense it was in Java that the conditions were to be found for a prosperous, mighty State, which could rule here over a numerous population, and could thus obtain the supremacy over other parts of the Archipelago, which happened to be less prosperous and less numerous in population. Trade centra could come into existence in a number of other places: Malacca, Atjeh, Djambi, Palembang, Macassar; the central power however had to be in prosperous, densely populated Java.

And though the Javanese history points out several centra of power to come into existence side by side, or one after the other: Prambanan, Medang, Kahuripan, Kadiri, Djanggala, Singasari, Madjapahit, yet in Java the hegemony in the Archipelago was situated.

Until the decline comes in the 15th century with the usual native

symptoms: difficulties of succession, dissension, civil war, famine. And then the power comes into other, here Mohammedan hands. This religious-political power had also come into the Archipelago through Malacca Straits, together with commerce, and had established itself in the international trade-centra: Perlak, Tuban, Gresik, later (in the 15th century), also in the palaces of the Javanese interior, and the political fall of Madjapahit meant also conversion to the Islam. And Mohammedan Demak, which has the hegemony over a great part of Java, and which later (16th century) was succeeded in that respect by the State of Mataram, was also situated in populous, prosperous Central-Java.

With the cloths from British India come the doctrine of monotheism, the personal relation of man with Allah, a better position of women, the religious institutions, the decline of art, self-exaltation and reticence.

And when the East-India Company receives in the middle of the 18th century the old kingdom of Mataram from the hands of Paku Buana II, torn as it is by dissension and discord, then the second little kingdom of Djokjakarta comes alongside Surakarta, and this kingdom gets another opponent in the Mangkunagaran. Afterwards the Pakualaman comes under Raffles and still later those districts become residencies and the Manthanagara are put under the direct rule of the Government. Then Western influence with its great assets has absolutely established itself here and elsewhere in the Dutch Archipelago: with knowledge which is power, with organization, progressing systematically, with will-power, which perseveres in spite of adversity, with energy which, continually renewed from the Homeland, knows of no fatigue. This Western power is being driven by desire after gain, after fame, after knowledge, and is based on patriotism, on ambition to govern well in the eyes of the world, on longing to raise the population to a higher level, and to spread abroad a higher civilization, and finally to put into action an educational system which can lead to more welfare and happiness.

That is the third, the West European period of civilization, after some hesitation naturally focussing itself again on Java — which was historically indicated to become its centre — and from there gradually domineering the whole Archipelago and establishing there: order, security of person and possessions, punctuality, regularity, exertion of the will and sense of duty, good laws, maintenance of justice and of the police, care for the health of man and animals, care for agriculture, for forestry, commerce and industries, means of communication by land and by sea, education in all its aspects and a great deal more. But above all: the unity of the Netherlands-Indies with Java as a natural and historical centre for the administration of Government. Java will remain that

for ever in the Archipelago; Criwidjaja, Malaju, Macassar, Ternate could in their time be centra of commerce, navigation or science; they lacked however the fertile, vast, populous hinterland, necessary for a political power-centre, which must always be able to send out people from a prosperous environment. And Java was prosperous in comparison with the other islands of the Indian Archipelago, probably from as early as the first century of our era, when it was already called Yawa, after the principal product of the island, the corn, the millet, the rice. In this light we must look upon the establishment of the Pax Neerlandica in this island, and from there throughout the whole Archipelago. Java could become very densely populated, because soil and seeds were already there to come to full growth through the management of the Netherlands.

In the first place by establishing order and security, for there is nothing so detrimental to the growth of population as continual unrest and mutual warfare, which are typical of native societies. The importance of these native wars is often overestimated. They principally made themselves felt, not so much by means of a great number of victims in a direct sence, as by the unrest, the insecurity, which the hostility among different communities brings with it.

In the native communities which were left to themselves tribal- or village wars, with slavery of the prisoners, head-hunting and so-called „hongi" campaigns were daily occurrences. Village duels, village tournaments and head-hunting campaigns took place, especially because the need of hunted heads made itself felt again and again: for the strengthening of the group, in the case of marriage and house-building, and for the house of the spirits, etc. People lived nearly continually in a state of unrest, of hunting or being hunted, with all the bad economic consequences connected therewith. Even if with higher civilization the village wars were mostly limited to periodic duels among a few people near the village frontiers, yet beside these, bloody and long wars are known in several islands, with feuds, which expressed themselves in vengeance and revenge, and in which sometimes a great number of men took part, who were under compulsory service for war.

The Dutch Authorities put an end to this state of affairs, and even if usually the number of the slain in battle was not great, the condition of unrest acted unfavourably upon welfare, health and birthrate because of the raids upon each other's territories, the always threatening attacks on each other's villages, the destruction of weirs and water works, the burning of the crops on the fields, the robbing of transports and the hindering of the transport of agricultural products. Unrest prevailed in the country; after sunset people did not dare to leave their houses,

they buried their dead within the village or in their own premises, and when the state of insecurity lasted a long time, then brushwood, or even trees, sprang up on what was field before.

And when we learn that in about the 10th century and after, Central Java seems to have been destroyed, because no historical details of those times have come down to us, then the question arises whether that central cultural territory of Java's classical period has not been the scene of a contest between rising East-Java and the central powers of those days, which had retreated towards Western Java, a kind of battle-zone, a "Tanah Radja", such as we know elsewhere, a ravaged region, such as was to be found in other islands too. But now unrest has come to an end; the Dutch Government has established peace and order everywhere, for open signs of hostility among the different jurisdictions there is no longer room; the safety of person and of goods of all parties is guaranteed, and, to use a native metaphor, „in the shadow of the protecting Power-screen the native peoples can thrive".

## SECTION IV.

Before these words can be further explained, it is again the comparison of the conditions in Java with those in the other islands of the Indian Archipelago, with reference to three harmful factors against the growth of population, which may be instructive here.

These three are: the great infant mortality, the so-called child-marriages, and polygamy. There are of course, numerous other social circumstances which have an influence on the welfare and the growth of the native communities: the small desire to acquire more than is necessary for the immediate satisfaction of one's needs; the produce-household which does not lead to an active increase of welfare, a fatalism leading to indifference, a conception of life, still prevailing in many respects, but really habitual with man in the pre-technic era, when he was not yet liberated from the fears of nature, a home-life in which the position of woman often leaves much to be desired, weakness and ignorance in the education of the children, an exaggerated sense of the family-ties, which allows many relations to sponge on the one, who possesses something; the extravagance at feasts and the love of splendour shown forth, whenever hospitality is felt as an obligation to one's situation in life, lack of individuality, sensitiveness to praise and flattery, the lack of self-control resulting in extravagance, and lack of thrift, etc. [1])

[1]) Eindverhandeling van de Volkswelvaart op Java en Madoera (1914) p. 77 ss. And to compare about the economical weakness of the natives in British-India: MADIA and JOSHI. The Wealth of India. 1925.

But among these harmful social influences, the three first mentioned especially must be named, and of those in the first place the great infant mortality. Thanks to the very favourable economic and social relations, the birth surplus in Java would be very much bigger still, if the mortality at an early age were not so abnormally high. Through lack of a decent Western registration of births, deaths and marriages for natives, we cannot but indirectly get an insight in this subject. Firstly it can be stated that in 1925 the general death-rate in Java and Madura amounted to 19.8 and in 1926 to 21.6 per thousand, against 9.8 per thousand in the same years in the Netherlands. With reference to some plantations at the East-coast of Sumatra the following figures are given concerning infant mortality [1]).

| | | |
|---|---|---|
| SMITS and BAERMANN | 1st year of life | 24 % |
| | 2nd „ „ „ | 7 à 10 % |
| | 3rd „ „ „ | 1½ à 4 % |
| | 4th and 5th year of life | 2½ % |
| DOORENBOS | 1st year of life | 35 % |
| | 2nd „ „ „ | 15 % |

STRAUB. In their 15th year, 50 % of all the children, born on the estate, have died; in Europe this is only the case after the 50th year.

According to KRUYT (De Bare'e sprekende Toradja's II, p. 55) most children in Central Celebes die between their 1st and 2nd year, with some tribes 57 % of the children, elsewhere 22.6 %, 18 %, 16 %. It seems evident that there is a question here of a very high rate of infant mortality, and that this is indeed the case in the Indian Archipelago, also and especially outside Java, appears from the following particulars. In several parts of the world the only possible method of investigation consisted in asking all the adult women of a definite group to state the number of children each one of them had given birth to up to the time of the inquiry, and also the number of those who had died by then. In this way one can get some insight into the infant mortality. So the percentage of the children who died calculated from the number of children that were born amounted to: [2])

| | |
|---|---|
| In the Low lands of Padang | 27 % |
| In the Fidzji-islands | 48.5 % |
| In Cameroon | 47 % |

With the Dyaks in the Western province of Borneo [3]) the rate is

[1]) STRAUB. Kindersterfte ter Oostkust van Sumatra. 1927. p. 17 s.s.
[2]) Tijdschrift Kon. Ned. Aardrijkskundig Genootschap. 1912. p. 819.
[3]) J. LATER. Koloniale Studiën. 1925. p. 97.

said to be 75 %; in Tanimbar the birth-surplus is said to be 2. 7,in Central Celebes 2.3 on the average to every woman [1]).

Compared with these high mortality rates, the harmful causes of a smaller number of children, the long lactation period, sexual abuse, abortion, infanticide, perhaps also inbreeding, are driven to the background [2]).

This is, however, not the case with the so-called child marriages, by which is meant that very young, and often not yet full grown girls, are married to younger or older men. This abuse is the result of other bad conditions of the native society, to wit: the desire to give the girls a position before undesirable elements cast their eyes upon them; the longing for heirs; the sense of shame attached to a prolonged unmarried state of the girls; the pre-conceived duty of the parents to marry off their children; the prevention of disgrace for the family in connection with the very free intercourse among boys and girls, etc.

The disadvantages ensuing from these corrupt customs for the very young mother and her progeny are obvious, moreover when one takes into account that native women mostly have to work hard, and as a rule get old at an early age.

Usually these child marriages are not of long duration, and divorce soon follows, after which, in a second marriage, man and woman can be more independent and freer in their choice.

Several tribes in Sumatra are more or less notorious in this respect, but also in Borneo, Celebes and Java this factor is sure to have an influence on the number of inhabitants. In this an improvement can be brought about by the provision of a good education to boys and girls, in order that their individuality may develop and that the younger and modern native generation may make a stand against this disgusting custom of the elders. This is the more necessary because the Moslem law makes no objection to marriage contracts, by which children are joined together in matrimony, and in particular cases even emphatically admits them. In the better classes of the Javanese Society the child-marriages are as a rule a thing of the past, and to marry off girls below sixteen is considered undesirable [3]). More seems to be expected in this respect of the good example of leaders of the Javanese Society than of regulations [4]), the

[1]) H. F. Tillema. Opbouw. 1925. p. 714.

[2]) A. J. Lucieez. Het kindertal bij de volkeren van Ned.-Indië (buiten Java) Tijdschrift Kon. Ned. Aardrijkskundig Genoot chap 1924. p. 540, 702. See also Seifert u. Oettl. Beziehungen zwischen Säuglingssterblichkeit und Rasse. Archiv. für Rassen und Gesellschaftsbiologie, 1927. S. 257.

[3]) A. Mühlenfeld. De Taak. 1917. p. 160.

[4]) Indische Gids. 1926. p. 243, 1927. p. 1031.

observation of which could not be controlled but with great difficulty.

Development of the personality, the good example of the leaders, higher civilization on the basis of good economic conditions, all this should bring improvement in the abuses put forward here. That much can still be done in this respect appears from the fact that in Java the first marriages of the women take place in about their thirteenth year, and of the men in their fifteenth. So that in Java five generations are born in 55 years to three in the Netherlands.

Also in the case of polygamy (polygynie) school teaching to boys and girls has had a favourable influence. The conversion of Java to the Islam, which became a fact in the 16th century, and which has brought about that now nearly all the native inhabitants of the island embrace the Mohammedan religion, has in this respect worked an improvement in comparison with the Heathen and Hindu societies in which licentious conditions prevailed with reference to polygynie. In general it can be said that the Islam improved the position of the women, which could often be called very unfavourable in the above mentioned communities, and that contraceptives are not being applied to such an extent in the Mohammedan Society as is the case in the Heathen or Hindu one.

In Java one man in every 70 married men lives in polygamy; outside Java one man in every 30 married men, so that Java does not cut a bad figure in this respect. The more independent the girls begin to feel, and the more her self-respect increases, the less polygynie and all subsequent evils will occur.

## SECTION V.

Meanwhile it will be clear that all measures, taken by a colonizing Power, very closely hang together with the racial qualities, the level of civilization, and the environment (monde ambiant) of a particular population.

Generally speaking the Javanese is less strong physically than the European or the Chinese; therefore the morbidity, the lethality and the mortality are greater with the Javanese than with the Europeans and the Chinese, and it is clear that the physical and moral influence of some diseases, such as malaria and ankylostomiasis upon the energy of the Javanese must be very great.

The unceasing action of the hot-house climate by exertion soon leads to fatigue, while on the other hand it facilitates the struggle for life, as the mild climate yields much with little labour.

For the rest neither man, nor his society, nor his way of thinking, nor his moral conception, ask for more than is necessary for the direct satisfaction of his needs. In as far their philosophy and their religious

feelings assert an influence, they often lead to fatalism, carelessness or indifference (also towards earthly possessions) and to practices of animism, where they should have acted on a basis of reality.

As a result of the strong sense of relationship, which is very prevalent, many relations sponge on relatives, who are comfortably off; it is taken for granted that debts need not be paid to such, and every one is apt to have pity with those among close or distant relations who are less blessed with earthly goods. Active increase of welfare, the commercial spirit and differentiation in business are only to be expected when the change from a produce-household into a money-household shall have come nearer towards being an accomplished fact. The increase of the number of literate people, amounting to 6 % of the population older than 15 years of age, will promote conscientiousness in the meeting of obligations entered upon. Elementary education, which brings with it order, neatness, punctuality, does more in this respect than the inculcation of knowledge. At family parties people seem to consider it due to their station to do much for the sake of appearances. The Javanese are very sensitive to praise or blame coming from the side of public opinion, and consequently they are hospitable in an exaggerated way and very fond of making a show. They are extravagant with money and have little self-control in this respect, they show a lack of individuality, strength of mind, character, independence; they are captives in the bonds of the morals of their nearest surroundings, and in certain quarters it has been reproachfully said with reference to the „fatherly Government" and „the love for the Native" of the Dutch that the immaturity of the Javanese has been promoted, or at any rate facilitated, thereby. Education, sports, literature can bring about an improvement in this direction. This outline shows a race with many infantile qualities and with a shortage of disinterested leaders of its own, who indeed do exist, but whose number should be more considerable for a population counting 35 million souls, to be instrumental in raising the whole people by its own energy to a higher level of welfare and happiness. For the time being that task has been reserved for the Dutch, and so the Dutch Nation bears the responsibility for the pedagogic task to educate a people, which, with some boldness, may be typified as: a fairly intelligent, emotional child with a good disposition, mostly obedient; healthy with continuous care, but not very strong of constitution, with not too many vices (gambling, opium).

With reference to results obtained in that task it is desirable to give the word to foreigners, and we may refer here to the following books, written in French: Chailley—Bert: Java et ses habitants (1914) and G. Angoulvant: Les Indes Néerlandaises (1926).

Which then are the principles upon which Dutch Rule is based, and the application of which has produced such noticeable results that there can be a question of India felix?

These principles are founded upon respect for, and protection and development of the native society and ideas inherent therein. Respect for Native conceptions is guaranteed by the law with reference to religion, in principle also with reference to custom-law and also as much as possible with a view to the preservation of native government institutions.

The protection of the native population is one of the most important duties of the Governor General; it does not only include the checking of arbitrariness towards the native populations from who ever it may be, but also the care for its economic interests, expressing itself in the protection of useful industries, and in the opening up of the country to Eastern foreigners by a gradual abolishment of hindrances in this direction. That protection is especially noticeable in the agrarian sphere, which, together with the maintenance of the rights of the population to the land, shows up the native as less virile economically, and possibly also spiritually and physically, in comparison with other groups of population. The Government regulations wish to protect him against injury by others with reference to his irrigation interests, and in his status of agrarian workman, and this is shown particularly by the regulation of landed-property. The transfer of the right of possession of land by Natives to non-natives is not valid according to the law. Such a regulation springs from the desire to protect the Native against his own passion for direct financial profit, of which enterprising non-natives might make use to trick the Natives out of their arable land. At the present state of economic development of the Natives and their society this measure still seems to recommend itself in many respects from the point of view of racial politics, as a considerable transfer of arable land now belonging to natives, to Europeans and to foreign Orientals might be expected in the case of the abolishment of these measures. The result would be an increased Native proletariat, which would inevitably more strongly emphasize the contrast with peoples of other races, while now many natives are and remain well-to do people, by reason of their landed properties. The greater force which is said to originate from the non-natives, economically, and probably in other directions as well, has called forth protection of the natives with respect to the rent of their land. The striving after material and intellectual development of the Native society appears from the system of Government in the widest sense, while the government also recognizes the importance of a moral, intellectual and social uplift of the native by private persons and associations; among other things it shows its favourable disposition

in this respect by giving financial support. Public education for the native population, with absolute deference to every one's religious convictions, is an object of continuous care of the Government. That care reveals itself in the support given by the government to education supplied by native communities, and also to the public native schools for elementary education, which are being established more and more for the children of the notable, well-to-do natives, as well as for the children of the native population in general.

Courses of continued and advanced elementary education, as well as the institutions for Secondary European education, are open to the natives.

Professional education is supplied at training colleges for native teachers, at training colleges for native civil servants, at colleges for the medical and veterinary service, at technical schools, at the agricultural colleges, also intended for prospective native civil servants, the "culture school", etc. Universities for the technical, juridical, and medical sciences crown the grand educational system. These schools are instrumental in accomplishing that beside these new needs, arising from the world traffic and improved means of communication, new means of living are found to meet those needs.

The people's credit system supplies material aids and appliances and working stock to native, and endeavours to promote native professions and business, commerce and industries, and to stimulate and encourage thrift.

Government, jurisdiction, maintenance of justice and police, inspection of labour, medical inspection by which the state of public health is examined and means for improvement are suggested. Government control of agriculture, by which means are devised to ensure more permanently satisfactory results to native agriculture (irrigation), the civil veterinary service, care of forest service, commerce and industries, care of a vast system of all kinds of ways and means of communication, all this shows great interest and pains on the part of the government. That this interest should not give a handle to criticism, who is there who would maintain that? Who is there, who would, for instance, deny that desires for more, better, quicker, and earlier results could be uttered with more or less good reason! But from these sketchy informations it must be clear that in Java an extensive apparatus is set to work at the uplift of the Native peoples. And that the matter is not one of principles alone, but that measures were taken, will be clear to every body who travels in Java. From the middle of the 19th century onwards, for instance, measures were taken for the relief of the burdens of the population, in the interest of native agriculture, for the encouragement

of native trade and industry, for irrigation and free labour, in the interest of the cattle stock, for the protection of native agriculture in connection with the European agricultural industry, for the protection of the Native with reference to labour contracts, against vexations and abuses by Native civil servants and others, in the interest of personal freedom, in connection with the pilgrimage to Mecca, for the campaign against the use of opium and against gambling, in the interest of public health, in the interest of public education, with reference to jurisdiction and police, in the interest of economic welfare and against poverty and begging, further in the matter of the native communities and the government of the natives, which is founded on this great principle: as much as circumstances allow the native population is put under the immediate rule of their own leaders, appointed or acknowledged by the government, subject to the higher supervision of the Dutch government officials. So the population is governed by their own leaders appointed by, and receiving instruction from the Dutch civil servants. Besides, an extensive system of all kinds of ways and means of communication, by sea as well as by land, has been established. A whole network of railways, tramways and car-roads has been spread over Java, which consequently offers as many and as great facilities for travel as any European country.

## SECTION VI.

Finally something remains to be said about the hygienic care [1]) of the 35 million inhabitants of Java.

It must be said in the first place that this happy land does not know of many scourges of other tropical countries: such as sleeping-sickness, yellow fever, recurrens, schistosomiasis (bladder worm), Kala azar, and plague, although this last mentioned disease has made its appearance in Java, and great exertion is needed to keep its number of victims as low as it has been up to the present.

As far as the small pox are concerned, these formerly infested the native communities, sothat people counted their age according to the number of small pox epidemics (one assumed that decimation by small pox occurred every seven years).

In 1884 vaccination began its triumphal journey and, thanks to the system of vaccination and revaccination operating throughout the whole island, administered by Javanese vaccinators under supervision of European medical men, this disease has lost its importance. To give an idea of the extensive measures taken in this matter, it may

[1]) See R. Pearl, The biology of population growth. 1926.

be said that in 1923 more than one million vaccinations were done in Java and about 1.8 million re-vaccinations.

Moreover the population of Java, where the influence of the Dutch Government has been making itself felt so long and so intensely, has more resistance against disease than the natives of regions, in which the care of the Dutch has not made itself felt so long or so strongly. Such populations, to a large extent left to their own devices, are placed exceedingly labile in their surroundings, which often are extremely unfavourable to start with; the number of inhabitants can hardly be maintained, or increases very slowly, and here becomes evident the lack of favourable circumstances, which are prevalent in Java, and which were discussed in the preceding chapters.

Apart from plague, the following diseases remain to be combated among the population of Java: malaria, hook worm disease, cholera, dysentery, typhus, framboesia, venereal diseases, beri-beri, pneumonia, tuberculosis, etc., diseases which, taken over the whole population, cause a mortality, varying between 18 and 20 per thousand per annum, but which in some areas or places, increase the mortality to 50 or more per thousand per annum.

The task to decrease this deathrate has been enstrusted to the Public Health Department, which exercises State-supervision upon public health, sees to the training of medical men, and watches over the medical practice and over the dispensation of medicines by medical men, as well as over the practice of the pharmaceutics.

Four inspectors belong to this Department; they each have a part of Java under their control, and a very numerous staff, expert in all kinds of subjects. In Java about 550 medical men are working; a number of these are Javanese, who enjoyed an excellent training at the two universities for the training of native doctors, which turn out 15—25 graduates per annum (500 pupils, 20.000 patients are treated yearly at the policlinics which form part of these universities). The Government also sees to the training of midwives, analysts and controllers of public health, chemist's assistants, nursing- and other assistant staff. Then there are in Java a Government vaccination station and an Institute Pasteur, three mental hospitals (5000 patients), an ophthalmological institution (4500 patients per annum), a number of local hospitals, a couple of hospitals for lepers, etc.

So we see as the cause of the great density of population in Java in comparison with that of the other islands a complex of factors: geographical, geophysical, economic, sociologic, historic, politic, which it is desirable to know all, in order to explain by them the demographic

facts. But not only does our demographic knowledge and that of the above mentioned factors leave much to be desired, but the mutual relation of all these circumstances has not yet been studied in a satisfactory way. The Dutch Indian Annual Report is not by a long way to be compared with the Census Report of India with its abundance of particulars, not only of a demographic nature, but also with reference to allied subjects, which are of the highest importance for a correct idea of the different groups of population.

Once the institution of Intelligence Departments in each of the large islands and island groups of the Dutch Indies has become an accomplished fact, it will be possible, not only to prevent the repeated appointments of incidental committees of investigation into economic or political facts, but also to dispose of preventative means of control, which will be useful in taking measures that in their turn might lead towards government regulations, working in the interest of the complex of native peoples and societies.

Amsterdam, Maart 1928.

# JURISPRUDENCE IN THE NETHERLANDS EAST INDIES

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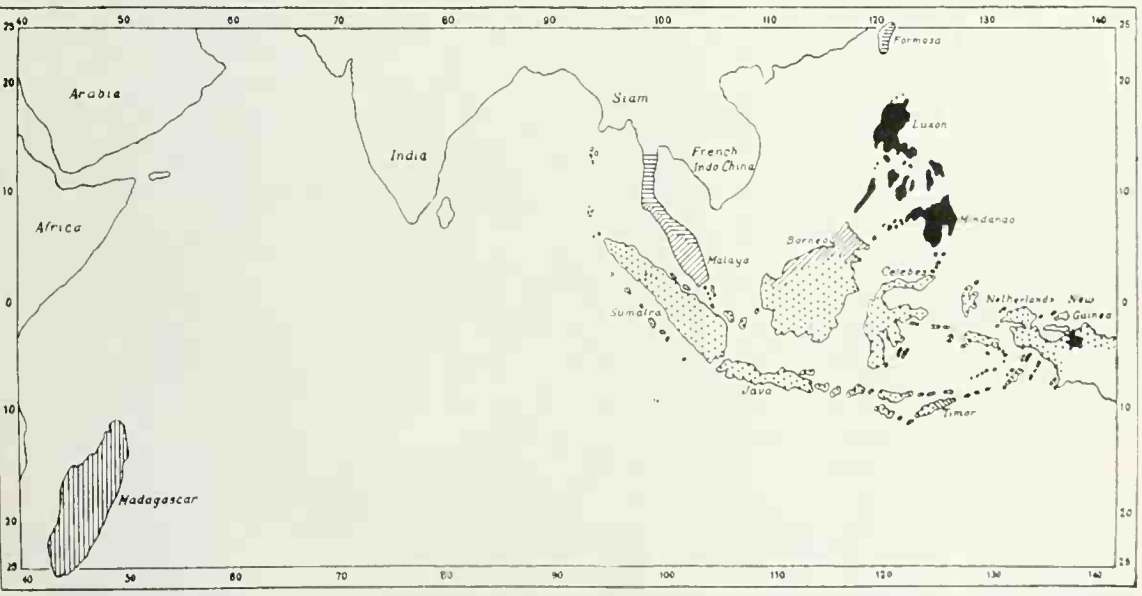
## I.

The study of law in the Netherlands East Indies does not date from the arrival of Westerners, whether Portuguese, Spaniards or Dutchmen. In our middle ages Java had had some native jurists of importance,




*Area of Indonesian customary law*

such as king Dharmawangça of Eastern Java and his legal advisers (about 1000), such as the author of Kutáramánawa, a law book (before 1350), or the chancellors of the Javanese realm, Gájah Máda (about 1350)

and Kánaka (about 1420). Their knowledge, however, was not maintained by a posterity of jurists, and a new jurisprudence had to spring up on the very ruins of the old.

The development of jurisprudence in the days of the United East India Company (V.O.C.), 1602—1800, was greatly hampered by four quite natural circumstances. Most of the legal rules introduced by this chartered company consisted merely of the common law and statutes of the United Provinces in Europe, slightly modified to suit tropical conditions; this means that, where under different circumstances an independent branch of East Indian jurisprudence might have come into being, a mere adaptation of home jurisprudence was found. In the second place: the chartered company did not show any real interest in native law conditions and legal relations until 1747 (for the interior of Java), and then it was too late and the Company too decrepit to make a start which might promise any success: men interested in native customary law like VAN GOENS (about 1660) and GOBIUS (about 1720) were quite exceptional, men trained in native customary law were lacking. In the third place: inasmuch as the Company's organization was of a type different from what existed as provincial or city organization in the mother country, a separate study of East Indian constitutional law might have been expected; but a Company's organization, apparently, was considered of minor importance from the lawyer's point of view, and this matter was neglected as well. In the last place: there was no seat of academic training or scholarly learning in the archipelago; the commendable institution, in 1778, of a Batavian Society for Arts and Sciences came too late to exercize any influence on the Company's last days.

Nor did the introduction of state government in the East Indies (1800) engender a real taste for juristic studies. Another half century had to pass before the germs of an East Indian jurisprudence gradually came to the surface.

## II.

May 1, 1848, is the date on which a complete set of codes (with the exception of a penal code) was given to the governmental administration of justice in the archipelago, viz.: (a) a code for the administration of justice both to Orientals and Europeans, (b and c) two codes of substantive private law for Europeans, all over the archipelago, (d) rules of procedure for civil and criminal suits against Orientals in Java, (e) rules of procedure for civil suits against Europeans in Java, and (f) rules of procedure for criminal suits against Europeans in Java. This type of legislation was not a result — as in MACAULAY's case it was for India —

of a serious contemplation of its advantages and disadvantages; it was a mere imitation of the codification system introduced by the Napoleonic régime in the greater part of Western Europe, and since then considered as self-evident. In 1849 a periodical for the publication of awards of juridical importance and of juridical essays was started (Het Recht in Nederlandsch-Indië, 1849—1914); in 1863 a second, on somewhat different lines and of a different size, followed (Indisch Weekblad van het Recht, 1863—1914). In this codification of 1848 a starting point for juristic studies had been given for jurists in the Indies interested in private European law and in adjective law of all types.

The authors of this codification, among whom two jurists are prominent (Scholten van Oud-Haarlem † 1849, and Wichers † 1853), had, as far as was feasible, followed the texts of the codes in force in the Netherlands since 1838; and in 1854 a provision was enacted at The Hague to the effect that the law for Europeans in the archipelago should resemble the law of the mother country as closely as possible. From that day, the Dutch East Indies have seen a long line of able jurists, either magistrates or lawyers practising at the bar, well versed in these codes and in the legal technique pertaining thereto; but they themselves consider their knowledge mainly as a knowledge of Dutch codes in their East Indian garb, and in the period of full eighty years that has passed by since 1848 not even one commentary or general text book on the two codes of substantive private law for Europeans in the Indies has been published. A good number of valuable special essays, however, has been devoted to this branch of jurisprudence. Just as American lawyers are well acquainted with the main lines of British law and jurisprudence, though not all British lawyers feel interested in American parallels, so lawyers in the Indies study cases and books published in the Netherlands assiduously, whereas in the mother country jurists often ignore the remarkable work that is being done in the juristic domain in the Dutch part of Asia.

The development of penal law was somewhat different. A code of substantive criminal law for Europeans took effect in 1867; it was followed in 1873 by one for Orientals. The two codes were of the same tenor and in the main even the wording was identical; they were both of them modelled after Napoleon's penal code. Even Macaulay's penal code for India, enacted in 1860, theoretical and lop-sided though the achievement may have been, had given more specific attention to tropical needs and conditions than these codes did. This very unoriginality of the codes, however, gave birth to the first book on East Indian substantive law which bore a truly East Indian stamp. Mr. De Gelder, vice-president of the Supreme Court of the Dutch East Indies at Batavia, published

in 1886 a treatise on substantive penal law in the archipelago (in two volumes), which emphatically and circumstantially stated the necessity to apply the code in the full consciousness of economic and social conditions in the tropics, of native customary law, and of the aim of a penal code for a given society. The book — reprinted in 1897 and in 1914 — continued for several years to furnish magistrates and lawyers in the Indies with information about criminal law and government policy in penal matters. Before that time, in 1872, Mr. DER KINDEREN, a high government official, had published the considerations on which the native penal code had been based, and in 1884 Mr. W. WINCKEL had published an exhaustive treatise on rules of procedure for Orientals, both in and outside Java and both in civil and criminal suits; a treatise which from beginning to end was an original work, the penal part of which was republished (in a modern form) in 1920.

No jurist has contributed more towards the expounding of the genesis of most of the Indian codes than Mr. IMMINK († 1914).

III.

A new incentive to the study of legal matters in the archipelago presented itself in 1909, when the first school specialized for legal training was opened in Java: a school for the training of Indonesian lawyers. From 1867 on, it is true, some law training had been given to the students of an older school, the school for the education of European civil service officers at Batavia, the so-called department B of the „gymnasium (high school) Willem III": and the curriculum of the several schools organized for the training of Indonesian civil service officers in Java contained some law training as well, both in public and private law. But the school of 1909 was specialized for this task, and placed on a higher level. The main importance of this school consists in two of its effects: (a) it produced a pretty large number of Indonesian lawyers, entitled even to preside over any native tribunal in Java and many of whom went to Holland in order to complete their legal education by acquiring some university degree; (b) it became the predecessor of the law university at Batavia, opened October, 1924. It is this law university which has removed one of the great hindrances of an independent study of East Indian law, by creating a seat for the purpose of studying and teaching law in the country itself. The government has been happy in the choice of the first appointees in the university chairs of 1924, and found a distinguished law professor from Holland, Mr. VAN KAN, willing to preside over this Batavia law faculty for the first five years (1924—1929).

In the meantime, in addition to the problem of studying and

interpreting the existing codes, the problem of replacing them by better ones had come to the fore. Unfortunately, however, legal enactments of 1906, 1919 and 1925 repeated the provision of 1854 stating that the East Indian codes should follow those of the mother country closely, and only deviate from these examples when specifical East Indian law conditions required this. A new penal code both for Orientals and Europeans which was enacted in 1915 and took effect in 1918 was again an unoriginal work, imitating as it did the Dutch code which in its turn had drawn largely from German sources. A commentary on this code written in the spirit of Mr. De Gelder's book, furnishing by its scientific information what the code itself failed to give, is still wanting, though in 1908 Mr. Van Ossenbruggen, at the time a teacher of law to Javanese students, at present (1929) Chief Justice of the Supreme Court of the Dutch East Indies, published a treatise on the general tenets of the penal law for Orientals.

The same problem of renovating the existing law had been raised with relation to rules of procedure and to private law. Of course the codes of 1848 had been repeatedly modified in detail because of modern needs and modern views, and many of these modifications were improvements. But the main problem which presented itself here was of a quite different type, and originated in the East Indian atmosphere. The real question with respect to adjective law in the Indies was, whether rules of procedure enacted for Orientals should not be in the fullest possible harmony with the rules of substantive customary law of the East, and, if so, whether the provisions of 1848 and afterwards should not be radically changed in many respects and replaced by provisions of a more Asiatic character. Suppose it were decided for Great Britain that English law should be applied by making use of French rules of procedure, or it were decreed at Paris that French law should be applied by making use of English rules of evidence and procedure, who would repose any confidence in the results? On the other hand: as to the two codes of substantive private law for Europeans, on one side stood a host of East Indian jurists claiming the extension of the main parts of these European codes to all Indonesian and foreign Orientals, whereas on the other side stood a gradually increasing group of lawyers who held that Indonesian customary law should be complemented or supplanted by European provisions only then, when the social needs of those Orientals themselves render such a measure urgent. Since the beginning of the twentieth century the scientific study of Indonesian law has developed to an extent which should seem sufficient to decide on these two problems. So far, a decision has not been reached; but the case for the customary law is much stronger now than it was some twenty years ago.

IV.

The principal dates for legislative decisions concerning the maintenance and application of Indonesian customary law are 1747, 1824, 1854 and 1919. In 1747 the East India Company, which so far had either not interfered with the aboriginal administration of justice, or had — within the precincts of its local authority (Batavia, Semarang, Surabaya and elsewhere) — applied Dutch law to both Orientals and Occidentals, decided to administer justice to the natives in the interior of Java as well (outside the three largest towns of Batavia, Semarang and Surabaya), and to do so in accordance with native law. In 1824 the government of the Dutch East Indies decided to abolish this exception to the rule of customary law, which was therefore, from that time forward, applied both to Orientals in the three larger towns and to those in the country. In 1854 this principle was inserted in the constitution for the Indies, enacted by the King and the States-General at The Hague. In 1919 the provision was changed to the effect that gradually Indonesian customary law should be replaced by statutory law, and that these statutes should respect native customs, unless there should be sufficient reasons for enacting universal private law for all categories of inhabitants, or for applying either European or other specific provisions to natives. This work of either codifying or replacing native private law has not been performed as yet.

The study of oriental customary law indispensable as a preliminary to this type of work was in a sense of recent date. The pioneer had been William Marsden (1783), an Irishman, who had served in Benkulen in Southern Sumatra when it still was under British rule (1684—1825). Muntinghe, a Dutchman, Raffles, an Englishman, and Crawfurd, a Scotsman, followed him closely. A new stimulus of interest had been given from 1865 to 1870 by the necessity of legislating on agrarian problems for Java. Wilken, first a civil service officer in the East, then from 1885 to 1891 a professor in the University of Leyden; Snouck Hurgronje, an Arabist and a student of native life in the East, since 1906 a professor at Leyden; Liefrinck, an excellent civil service officer in the two Hindu islands of the East († 1927); Mr. Van Ossenbruggen, the East Indian jurist mentioned before; university teaching in Holland, after Wilken and Snouck Hurgronje had paved the way; and professional teaching at Batavia since the birth of the law school (1909) and the law university (1924), — these have all of them contributed to our present knowledge of this branch of law. The number of books with information on Indonesian law — which covers an area reaching from Formosa to Madagascar, with 67.000.000 inhabitants, 49.000.000 of whom are under Nether-

lands sway (see the map at p. 375) — has greatly increased of late years: text books, monographs, surveys of literature, published awards, published reports, essays, etc.

V.

A few words should be added about Chinese law in the Indies. In former days purely European law had been applied to them within the Dutch sphere of influence. From 1824 to 1855 they lived under Chinese private law; from 1855 to 1919 or (elsewhere) to 1925 they lived partly under Chinese law (family and abintestate law), partly under European law (law on real and personal property, and on testaments); since 1919 and 1925 their Chinese law has been practically abolished. Mr. FROMBERG († 1924) was the able jurist who made Chinese private law accessible to his fellow-countrymen and had a great influence on the drawing of the present statutes.

VI.

Constitutional law in the Indies was during a long series of years neither a subject of theoretical research nor a matter of practical and political interest. During the greater part of the nineteenth century it did not undergo any substantial change, and the few text books rather confined themselves to reproducing the contents of the existing acts and provisions instead of analyzing them and comparing them with what really existed in the Indies.

In the domain of legal study, constitutional law was brought to the level of parallel studies in European constitutional law by the books of MARGADANT (1894—1897) and KLEINTJES (first edition 1903, present edition 1927—1929). Here also, the law university at Batavia is beginning to play an important part.

In the domain of practical politics, it was especially the extension and organization of Dutch authority all over the archipelago (1894—1909) which has brought into prominence an infinity of new constitutional problems related both to the organization of all kinds of local and provincial boards (native, or European, or of a mixed character) and to the reorganization of the central authorities. In 1918 a viceregal commission was appointed at Batavia to give report on these problems in their entirety; a parliament act of 1925, however, emanated from the Queen and States-General at The Hague, gave a solution to part of these problems only. Among the few original thinkers in this direction must be mentioned Mr. COLIJN, sometime an Indian army officer, and Mr. RITSEMA VAN ECK, sometime an Indian forester.

Among these constitutional problems one of high importance for the application of private and criminal law is that of the administration of justice. The man who contributed most to organize it since the codification of 1848 was Mr. DER KINDEREN, an influential East Indian jurist († 1898; see p. 378). From 1874 to 1882 he organized this branch of the law for the greater part of the island possessions outside Java. The important survivals of native administration of justice in those islands, with numerous governmental additions to it, have justly begun to draw the attention of jurists more than they did before, and raise interesting problems which cannot be solved by merely imitating European models.

In 1880 Mr. C. P. K. WINCKEL had published in French a sketch of the administration of justice in the Dutch East Indies.

## VII.

There have been academically trained lawyers in the Indies since the very first days of Dutch influence — one of the first and most honorable governors general was a university jurist (REAEL) — but for nearly three centuries they only occupied either a few high administrative posts or a few places on the bench of the Supreme Court and the main local courts (Batavia, Semarang, Surabaya, Macassar etc.). It was not until after 1870 that a regular influx of jurists was organized to sit on European courts of first instance and to preside over courts having jurisdiction over natives and other Orientals. A department of justice at Batavia was not organized until 1870.

From 1885 to 1887 there existed a private Association of East Indian jurists, which had its seat at Batavia. It held some meetings, but soon became anaemic. A second Association of East Indian jurists was formed in 1913, and is still in full force. It combined the two legal periodicals mentioned at p. 377 into a new one, styled „Indisch Tijdschrift van het Recht" (East Indian Law Journal; since 1914), and made it its official paper.

Neither studies of legal history and comparative legal history, nor studies of international law, have so far thriven in the Indies. But the new impetus which shows itself in so many parts may reach these areas as well. Ethnological jurisprudence has found a promotor, ever since 1902, in Mr. VAN OSSENBRUGGEN.

A survey of the science of jurisprudence as it has manifested itself so far in the Netherlands Indies will leave the reader unsatisfied. He will, however, realize the difficulties of these studies, hampered as they were by oversea conditions, and may be aware of a promising outlook for the near future.

# CONSPECTUS OF INSTITUTIONS OF PURE AND APPLIED SCIENCE IN OR CONCERNING THE NETHERLANDS EAST INDIES.

compiled by Dr. H. J. LAM,
*1st General Secretary of the Fourth Pacific Science Congress.*

## INTRODUCTION.

The following conspectus of institutes and societies dealing with scientific problems in the Malay Archipelago has been compiled with the kind assistance of the directors, managing-boards, etc. of the various institutions mentioned below. I wish to render them my best thanks for their support. I am moreover indebted to Dr. O. DE VRIES, Director of the Rubber Experiment Station at Buitenzorg who was kind enough to give me the outline of the general organization of private agricultural experiment stations in these colonies.

The present conspectus is partially based upon the previous paper by Dr. P. J. S. CRAMER, entitled: "Institutes for Research Work in the Interest of Agriculture in the Dutch East Indies" [1]). As a matter of fact, however, it extends over a much wider scope, as it also includes biological and physical institutions and even some few which deal with the humanities, in accordance with the ground-plan of this book.

Many of the institutions mentioned are maintained by the Government in the Netherlands East Indies; others are private. The latter are especially found among agricultural experiment stations. They have been arranged in accordance with the scheme, mentioned in the index, government and private institutions having been mentioned separately.

Only those institutes, laboratories, etc. have been mentioned which deal with scientific problems of any description. Consequently, the general organization of a number of Government services had to be left out; among these are: the services of irrigation-works (Department of Public Works), of agriculture and horticulture, of teak-exploitation, of government estates, of forestry, of the veterinary survey, of

[1]) Journal of the Pan-Pacific Research Institution I (Honolulu, 1926), nr. 2.

statistics (Department of Agriculture, Industry and Commerce), of public health and infirmaries (Department of Education and Public Worship), of the mining department and the state monopoly of salt (Department of Government Industries), of the state monopoly of opium (Revenue Department) etc. The Government Departments possess libraries, of which those of the Department of Agriculture, Industry and Commerce at Buitenzorg, and of the Department of Government Industries at Bandung are most important. There is also a library in the Office of the „Algemeene Secretarie" at Buitenzorg.

The numerous societies and periodicals for the promotion of public health, agriculture etc., or those concerning various professions have not been mentioned either, because they are of no value to the reader of this book. Full particulars concerning these subjects may be found in the „Regeerings-Almanak voor Nederlandsch-Indië" 1929, Vol. II. For others, cf. VII, Periodicals.

It goes without saying that so far as the staffs of some institutions are concerned this conspectus cannot claim to be fully up to date. It has been found impossible to mention any changes made since the end of 1928.

## INDEX.

### I. UNIVERSITY EDUCATION.

1. Faculty of Technical Sciences (Bandung).
   - *a.* Bosscha Laboratory for Physical Research.
   - *b.* Laboratory for Testing Materials (cf. No. 11).
   - *c.* Central Electric Laboratory of the Government Service for Waterpower and Electricity (cf. No. 9).
   - *d.* Laboratory for the Demonstration of Hydrodynamic Problems.
   - *e.* Roads and Road-constructions.
   - *f.* Laboratory of the Government Gauging Service.
2. Faculty of Law (Batavia).
3. Faculty of Medicine (Batavia).

### II. PHYSICAL SCIENCES.

*a.* **Astronomy.**

4. Bosscha Astronomical Observatory (Lembang, Bandung).

*b.* **Chemistry and Industry.**

5. Division of Industry, Department of Agriculture, Industry and Commerce (Buitenzorg).
   - *a.* Staff.
   - *b.* Intelligence Office.
   - *c.* Laboratory for Chemical Analysis.

*c.* **Geography.**

6. Topographical Service (Batavia).

*d.* **Geology and Volcanology.**

7. Government Geological Survey (Bandung).

*e.* **Geophysics.**

8. Royal Magnetical and Meteorological Observatory (Batavia).

*f.* **Technical Sciences.**

9. Government Service for Waterpower and Electricity (Bandung) (cf. No. 1 c).
10. Malabar Radio-telegraphic Station (Malabar, Bandung).
11. Government Laboratory for the Testing of Materials (Bandung) (cf. No. 1 b).

## III. BIOLOGICAL SCIENCES.

*a.* **Botany and Zoology.**

12. Government Botanic Gardens.
    - *a.* Laboratory of the Director (Buitenzorg).
    - *b.* Treub-Laboratory (Buitenzorg).
    - *c.* Herbarium and Museum for Systematical Botany (Buitenzorg).
    - *d.* Botanic Gardens (Buitenzorg).
    - *e.* Botanic Gardens (Tjibodas).
    - *f.* Botanic Gardens (Sibolangit, Sumatra).
    - *g.* Zoological Museum and Laboratory (Buitenzorg).
    - *h.* Marine Biological Laboratory and Aquarium (Batavia).
    - *i.* Phytochemical Laboratory (Buitenzorg).
13. Museum and Inquiry Office for Economic Botany (Buitenzorg).

*b.* **Medical Sciences.**

14. Public Health Service.
    - *a.* Medical Laboratory (Batavia).
    - *b.* Experiment Station for Water Depuration (Meester Cornelis).
    - *c.* Medical Colleges.
        1. STOVIA (Batavia).
        2. NIAS (Surabaja).
    - *d.* Government Vaccine and Pasteur Institute (Bandung).
15. Netherlands East Indies Cancer Institute (Bandung).

*d.* **Veterinary Sciences.**

16. Civil Veterinary Service (Buitenzorg).
    - *a.* Veterinary Institute.
    - *b.* Experiment Station for Cattle-breeding.
    - *c.* Experiment Station for Poultry-breeding.
    - *d.* Netherlands Indies Veterinary College.

## IV. AGRICULTURAL SCIENCES.

*a.* **Education.**

17. Secondary Agricultural College (Buitenzorg).

*b.* **Government Institutions.**

18. General Experiment Station for Agriculture (Buitenzorg).
    *a.* Institute for Plant Diseases.
    *b.* Agricultural Institute, Experiment Garden, Seed Gardens.
19. Forestry Research Institute (Buitenzorg).
20. Government Rubber Plantation Laboratories.
    *a.* Agricultural Research Department (Buitenzorg).
    *b.* Laboratory of the Gutta-Percha Estate "Tjipetir" (Tjipetir).
21. Agricultural Service, Department of Agriculture, Industry and Commerce (Buitenzorg).
    *a.* Scientific Commissioner for Freshwater Fishery.
    *b.* Horticultural Service.
    *c.* Division of Agricultural Economics.

*c.* **Private Experiment Stations.**

General Organization.

1. *West Java.*

22. General Tea Experiment Station (Buitenzorg).
23. Rubber Experiment Station (Buitenzorg).
24. Malabar Tea Experiment Station (Malabar, Bandung).
25. Cinchona Experiment Station (Tjinjiruan, Bandung).
26. Advisory Service of the Company for the Exploitation of the Pamanukan- and Tjiasem-Estates (Subang).
27. Experiment Station for the Java Sugar Industry, Branch Station Cheribon (Cheribon, cf. No. 32).

2. *Central Java.*

28. Central Java Experiment Station (Salatiga).
29. Experiment Station for "Vorstenlanden" Tobacco (Klaten).
30. Sugar Experiment Station of the United Klaten Plantation Company Ltd. (Klaten).

3. *East Java.*

31. Malang Experiment Station (Malang).
32. Experiment Station for the Java Sugar Industry (Pasuruan).
33. Besuki Experiment Station (Djember).

4. *Sumatra (East Coast).*

34. Deli Experiment Station (Medan).
35. General Experiment Station of the A.V.R.O.S. (Medan).
36. Research Department of the "Rubber Cultuurmaatschappij Amsterdam" (Galang).

37. Plantation Research Department of the United States Rubber Plantations Inc. (Bunut).

## V. HUMANITIES.

*a.* **Archaeology.**

38. Archaeological Service (Batavia).

*b.* **Ethnology, Law, Linguistics.**

39. Museum of the Royal Batavia Society of Arts and Letters (Batavia).
40. Native Reading Office (Batavia).

## VI. SOCIETIES.

41. Netherlands Indies Science Council (Batavia).
42. Netherlands Indies Pacific Research Committee (Buitenzorg).
43. Netherlands Indies Committee for Scientific Researches (Batavia).
44. Netherlands Indies Science Congress Society (Batavia).
45. Royal Science Society in the Netherlands Indies (Batavia).
46. Netherlands Indies Astronomical Society (Bandung).
47. Association of Chemical, Technical and Agricultural Advisors to the Java Sugar Industry (Surabaja).
48. Netherlands Indies Pharmacists Association (Bandung).
49. Association of Officers of the Topographical Service (Batavia).
50. Association of Mining Engineers and Geologists of the Mining Service (Bandung).
51. Royal Institute of Engineers, Netherlands Indies Branch (Batavia, Comm. at Sĕmarang).
52. Association of Civil Engineers in the Netherlands Indies (Batavia).
53. Netherlands Indies Natural History Society (Batavia).
54. Netherlands Indies Society for the Preservation of Natural Monuments (Batavia, Comm. at Buitenzorg).
55. Society for the Promotion of Medical Sciences in the Netherlands Indies (Batavia).
56. Society for the Promotion of Hygienics in the Netherlands Indies (Bandung).
57. Netherlands Indies Society for Veterinary Art (Buitenzorg).
58. Association of Government Agriculturists in the Netherlands Indies (Buitenzorg).
59. Association of Forest Officers in the Netherlands Indies (secr. at Sĕmarang).
60. Association of Experiment Stations Personnel (Buitenzorg).
61. Royal Batavia Society of Arts and Letters (Batavia).
62. Macassar Society of Arts and Letters (Macassar).
63. Netherlands Indies Bureau of Anthropology (Batavia).

# VII. PERIODICALS.

## I. UNIVERSITY EDUCATION.

*(Department of Education and Public Worship).*
*(Departement van Onderwijs en Eeredienst).*

### 1. FACULTY OF TECHNICAL SCIENCES (Bandung). (TECHNISCHE HOOGESCHOOL).

**History.** In the beginning of the year 1917 an association was formed on the initiative of leading personalities in Netherlands trade-, shipping- and agricultural circles, named „Koninklijk Instituut voor hooger technisch onderwijs in Nederlandsch-Indië" (Royal Institute for higher technical education in the Netherlands Indies), in order to collect the necessary funds to establish a Technical Faculty in the Dutch East Indies.

The task of designing the building and the execution of it were given into the hands of Ir. H. MACLAINE PONT, an architectural engineer. In the spring of 1919 the chairman of the Board of Directors, accompanied by professor Ir. J. KLOPPER — who had been invited to act as its first "rector magnificus" — sailed for the Indies, to execute the plans without delay. A fine site of about 30 hectares, in the north part of the city of Bandung, was presented to the institute by the municipality of this place.

The greater part of the eastmost building, is occupied by the "Laboratory for testing materials" (cf. No. 11) (Department of Public Works); the co-operation between the said laboratory and the Faculty has proved to be most satisfactory to both.

The westmost side building is divided into three parts, the central one forming a drawing-hall; the two other parts containing the library and workrooms.

The official opening of the physical-laboratories (at present named "Bosscha-Laboratory for Physical Research") took place on March 18th, 1922. In the workshops of this laboratory the "Vereeniging voor de opleiding van instrumentmakers en glasblazers" (Society for the training of instrumentmakers and glassblowers) instructs pupils of all races who have passed through the elementary schools.

Between the westmost building and the physics-department mentioned above a new complex of lecture-rooms, workrooms and drawing halls was built in 1924. As far as can be foreseen these will probably meet the demand for sufficient room in the next few years.

There is only one faculty, viz: that of Civil-Engineering. The curriculum extends over a period of four years, which has proved to be sufficient, owing to the fact that holidays are comparatively short and, in contradistinction to sister-institutions, attendance in the first two or sometimes three years is obligatory and subject to certain regulations.

Lectures are given daily during the morning hours (three times fifty minutes); after half an hour's interval the work in laboratories and drawing halls begins and is generally stopped at 1 o'clock.

On October 14th, 1924, the management of the Faculty was officially handed over to the Government of the Dutch East Indies.

The Government considers the diploma of the Faculty at Bandung equivalent to that of the sister-institution at Delft.

Situated in its grounds, though not belonging to the faculty, is the well-equipped central electric laboratory of the Government Service for Waterpower and Electricity (cf. No. 9), which was opened recently. The "Dutch East Indies Roads Association", whose executive staff has its headquarters in one of the rooms of the Faculty, has built a circular test road, with a permanent plant for mechanical traction.

Established (opened officially): 3 July 1920.

*Board of Curators:* ..... president; Ir. WOUTER COOL (1924), Dr. Ir. HAN TIAUW TJONG (1924), R. A. A. WIRANATAKOESOEMA (1924), N. VAN ZALINGE (1926), Prof. C. P. WOLFF SCHOEMAKER (1927), Ir. D. DE IONGH (1927), Prof. Dr. J. CLAY (1928), Ir. J. E. A. VON WOLZOGEN KÜHR (1928) members; C. DONKER VAN HEEL, Secretary. *University Professors:* Dr. J. CLAY, president, Professor of physics (1920); C. P. WOLFF SCHOEMAKER, secretary, Professor of architecture. Members of the staff: Dr. W. BOOMSTRA, Professor of mathematics (1920), Ir. W. H. A. VAN ALPHEN DE VEER, Extraordinary Professor of testing materials (1921), Ir. J. H. G. SCHEPERS, Extraordinary Professor of geodetics (1921), Ir. G. H. M. VIERLING, Extraordinary Professor of mechanical engineering (1921), Ir. H. C. P. DE VOS, Professor of hydraulics (1921) Ir. J. N. VAN DER LEY, Extraordinary Professor of electrotechnics (1922), H. M. NEEB, Extraordinary Professor of hygienics (1922), C. P. WOLFF SCHOEMAKER, Professor of architecture (1922), Ir. H. VAN BREEN, Professor of hydraulics (1923), Ir. P. N. MAX, Extraordinary Professor of general railways (1923), Mr. Dr. H. WESTRA, Extraordinary Professor of law (1924), Ir. C. G. J. VREEDENBURGH, Professor of mechanics (1926), Ir. P. P. BIJLAARD, Professor of general ironconstructions. *Library:* C. DONKER VAN HEEL, librarian. Books etc. registered about 6000. Periodicals about 200 (technical literature exclusively). Catalogue: card-index system, for reference in library only.

*Laboratories: a. Physics.* "Bosscha Laboratory for Physical Research", director Prof. Dr. J. CLAY, assistant Mrs. T. C. CLAY—JOLLES; *b. Testing General Materials.* "Laboratory of Testing Materials" (cf. No. 11), director Prof. Ir. W. H. A. VAN ALPHEN DE VEER, assistant I. A. MARONIER; *c. General Electrics.* "Central Electric Laboratory of the Government Service for Waterpower and Electricity" (cf. No. 9), superintendent Prof. Ir. J. N. VAN DER LEY, chief of the laboratory; *d. Hydrodynamics.* "Laboratory for the demonstration of hydrodynamic problems", director Prof. Ir. H. C. P. DE VOS; *e. Roads and Roadconstructions.* "Bureau of the N. I. Roads Association", president Prof. Ir. H. VAN BREEN; Jhr. Ir. C. ORTT, secretary; *f. Gauging.* "Bureau and Laboratory of the Government Gauging Service" (general weights, watermeters, gasmeters, benzine- and oilmeters), chief: J. P. DE VOS, assistant: J. DENEKAMP.

## 2. FACULTY OF LAW (Batavia—Weltevreden). (RECHTSHOOGESCHOOL).

**History.** The Law Faculty at Batavia was established to meet the want of a higher law training than could be obtained at the Law School at Batavia.

About May 1929 the law faculty will leave its temporary abode (11 Koningsplein Zuid) and move into its new building, now being prepared for it at Koningsplein West next door to the Museum (No. 39) of the Royal Batavia Society of Arts and Sciences (No. 61).

The library of the faculty, containing some 12000 books, has for the time being found accommodation in the Museum just mentioned.

In the last year of their studies the students of the law faculty may specialize

in four different directions, viz. those of: a. Civil law; b. Criminal law; c. Public law; or d. Sociological economics. Those who have obtained a certificate, after having specialized in Civil law or in Criminal law, can be admitted to legal professions or practise at the bar. With a certificate obtained for public law or Sociological economics they can enter the Civil Service. Established (opened officially): 28 October 1924.

*Board of Curators of the Batavia Faculties of Law and Medicine:* Mr. K. F. CREUTZBERG, president; Mr. L. J. A. TRIP, vice-president; R. A. A. ACHMAD—DJAJADININGRAT, H. H. KAN, W. P. HILLEN, Dr. CH. W. F. WINCKEL, members. Dean of the Faculty: Prof. Mr. A. H. M. J. VAN KAN, secretary: Mr. F. C. BARBAS. Number of students (1927/1928): 132. *University Professors:* Mr. A. H. M. J. VAN KAN, Professor of Dutch civil law and Roman law — R. A. Dr. H. DJAJADININGRAT, Professor of Malay languages and Mahomedan law — Mr. J. M. J. SCHEPPER, Professor of criminal law, criminology and philosophy of law — Dr. B. J. O. SCHRIEKE, Professor of social anthropology and sociology — Dr. J. H. A. LOGEMAN, Professor of public law — Mr. Dr. R. D. KOLLEWIJN, Professor of introduction to law and international private law — Mr. J. ZEIJLEMAKER, Professor of commercial law and civil procedure — Dr. J. v. GELDEREN, (acting) Extraordinary Professor of economics — Mr. Dr. F. M. BARON VAN ASBECK, Extraordinary Professor of international law and foreign colonial law — Mr. B. TER HAAR, Extraordinary Professor of native law — Dr. E. BESSEM, lecturer on Latin — J. KATS, lecturer on Javanese — Mr. G. VONK, lecturer on criminal procedure. On home leave: Prof. Dr. J. H. BOEKE.

**Publications**: Yearbook. Batavia 1925 — hodie.

### 3. FACULTY OF MEDICINE (Batavia—Weltevreden). (GENEESKUNDIGE HOOGESCHOOL).

**History.** Medical training was first given at Weltevreden to the socalled Java doctors (dokters djawa). This was begun (1851) in the Military Hospital by a military medical staff and the language spoken was Malay.

Though the original purpose of this medical training was to supply the long felt want of vaccinators, it very soon became evident that as a rule the graduates had to render medical aid generally, in consequence of the absence of doctors in the less accessible parts of the archipelago.

Hence the teaching was soon changed and native doctors were formed, able to work independently as medical practitioners. The curriculum was gradually extended; in 1875 the whole course of instruction was extended to a preparatory part of 2 years and a medical part of 5 years, and all the lessons were now given in Dutch. A laboratory was attached to the school.

In 1890 it was decided to admit only those native students who had attended European schools. A new establishment which can accommodate about 200 students was opened in 1901. It was called S. T. O. V. I. A. (School Tot Opleiding Van Inlandsche Artsen) (cf. No. 14 c 1).

In 1913 a second medical training-school, the N. I. A. S. (Nederlandsch-Indische Artsen-School) (cf. No. 14 c 2) was founded at Surabaja.

A new hospital was opened in November 1919; the new Stovia-building was opened on July 5th, 1920, and in 1926 the old medical school celebrated its 75th anniversary in the imposing new building at Salemba (Weltevreden). The moment seemed to have come to reorganize medical training once more, to extend it again and place it on a level with medical training in the Universities in Holland, with the same rights, the same examinations and the same methods.

In 1925 the Government appointed a committee whose task was to study these problems and to consider what steps would have to be taken to establish a Faculty.

Those who wish to study medicine now must have attended a European elementary school (with a 7 years' course) and a High School (with a 5 or 6 years' course), of which there are a number in several places in the Archipelago.

The student can finish the curriculum in $6\frac{1}{2}$ or 7 years. There is no difference between the diplomas of the Medical Faculty at Batavia and those of the Universities in the Netherlands.

The Faculty opened on August 16th, 1927; instruction in the propaedeutical branches began on August 22nd; the number of students was 24, among whom was 1 female student and 1 female auditor for Physics and Chemistry. For the second year 27 students have been registered, among whom 2 female students.

*Board of Curators* (vide No. 2) — Dean of the Faculty: Prof. Dr. C. D. DE LANGEN — Secretary: Prof. Dr. C. BONNE; Administrator: Dr. H. F. ROLL. *University Professors* — ....., Professor of anatomy and cytology — Dr. W. M. DOCTERS VAN LEEUWEN, Extraordinary Professor of botany — Dr. H. C. DELSMAN, Extraordinary Professor of zoology — Dr. J. BOEREMA, Extraordinary Professor of physics — Dr. O. DE VRIES, Extraordinary Professor of chemistry — Dr. W. A. MIJSBERG, Professor of anatomy — A. DE WAART, Professor of physiology — Dr. C. BONNE, Professor of general pathology, pathological anatomy and forensic medicine — Dr. L. OTTEN, Extraordinary Professor of hygenics, bacteriology and serology — Dr. C. D. DE LANGEN, Professor of internal pathology, diagnotics and therapeutics — Dr. R. LESK, Professor of surgery — N. J. A. F. BOERMA, Extraordinary Professor of obstetrics and gynaecology — Dr. C. BAKKER, Extraordinary Professor of ophthalmology — Dr. W. RADSMA, Professor of histology and physiological chemistry — Dr. B. J. VAN DER PLAATS, Extraordinary Professor of röntgenology — Dr. P. W. VAN WULFFTEN PALTHE, Extraordinary Professor of neurology and psychiatry. — Dr. H. F. ROLL, private University Teacher of medical jurisprudence.

## II. PHYSICAL SCIENCES.

### a. Astronomy.

#### 4. BOSSCHA ASTRONOMICAL OBSERVATORY (Lembang, near Bandung). (Private). (BOSSCHA STERRENWACHT).

Founded by the Netherlands Indies Astronomical Society (cf. No. 46); opened January 1st, 1923.

**Situation**: Southern latitude: 6° 49′ 29″.1; longitude (Greenwich): 7 h., 10 min. 27.73 sec.; altitude 1303 m above sealevel; distance from Bandung: 14 km.

Dr. Ir. J. G. E. G. VOÛTE, director; Dr. E. A. KREIKEN, Dr. A. E. A. WALLENQUIST, astronomers; A. J. WITLOX, instrument-maker; G. A. DENCHER, administration and library.

**Scope.** Mainly measurement of double stars, observation of variable stars, parallax observations. The observation of latitude-measurements in collaboration with Prof. KIMURA of Mizuzawa (Japan) is planned.

**Instrumentarium**: See Chapter on Astronomy of this book (p. 125—132).

**Publications**: *a.* Annalen van de Bosscha-Sterrenwacht — *b.* Observations of variable and double stars (published: Vol. I, 2nd and 3rd part; Vol. II, 1st and

2nd part) — *c.* catalogue of double stars (Vol. III, Ist part publ.) — *d.* short essays have been published in the "Bulletin of the Astronomical Institutes of the Netherlands".

**Library.** The well-known astronomical library of the late director of the "Leiden Observatory", Prof. Dr. J. G. VAN DE SANDE BAKHUYZEN, has been presented to the society and has found accommodation in the observatory.

## b. Chemistry and Industry.

### 5. DIVISION OF INDUSTRY, GOVERNMENT DEPARTMENT OF AGRICULTURE, INDUSTRY AND COMMERCE (Buitenzorg). (AFDEELING NIJVERHEID EN HANDEL VAN HET DEPARTEMENT VAN LANDBOUW, NIJVERHEID EN HANDEL).

Established as an autonomous division of that Department in 1918.

**Present State**: *a. Staff* — Director: Ir. H. L. WELTER — Industrial advisers: Dr. Ir. H. W. HOFSTEDE (hat manufacturing, citronella-oil, papain, jute and allied fibres); K. J. HOLTAPPEL, Chief, Laboratory for Chemical Analyses; Ir. R. M. P. SOERACHMAN TJOKROADISOERIO (Javanese batikworks, triplex and veneer manufacturing, fatty oils); Ir. DARMAWAN MANGOENKOESOEMO (Javanese batikworks, jelutung); Ir. E. K. E. HALEWYN (cassave flour manufacturing, jute and allied fibres). — *b. Intelligence Office* (especially for native industrial products) — Chief: K. G. V. MENTEL — Experts: G. DALENOORD (textile industries); W. HAITSMA and K. SCHIPHUIS (ceramic industries); W. CAVALINI (leather tanning and dressing) — *c. Laboratory for chemical analyses* — Chief: K. J. HOLTAPPEL — Chemists: Dr. J. ZIMMERMANN; M. VAN DER SLIK.

**Scope.** The Division of Industry of the Department of Agriculture, Industry and Commerce gives informations on industrial questions not falling within the range of other special governmental or private research institutes in the Netherlands Indies. For that purpose it disposes of a laboratory for studying industrial problems and of a chemical one especially occupied in analyzing industrial and commercial products. Moreover it manages at Bandung two institutions at which practical instructions are given concerning weaving and earthenware manufacturing to native craftsmen. A similar institution for practical tanning has been established at Buitenzorg. A subdivision deals with the exhibition of native industrial arts at fairs in the Netherlands Indies.

**Publications.** The publication of results concerning investigations carried out on subjects of industrial interest started in 1927. Up to the present the following papers have been issued: *a.* Ir. R. M. P. SOERACHMAN TJOKROADISOERIO: De batiknijverheid in de Vorstenlanden (Concerning batik industry in the Principalities); *b.* H. L. SPIEKERMAN en W. A. CAVALINI: Korte handleiding voor de leerlooierij (Dutch and Malay) (Short manual for leather tanning); *c.* K. J. HOLTAPPEL: Het onderzoek van citronella-olie (Investigations on Citronella-oil); *d.* Dr. Ir. W. H. HOFSTEDE: Citronella-olie; *e.* Idem: Papain.

## c. Geography.

### 6. GOVERNMENT TOPOGRAPHICAL SERVICE (Batavia—Weltevreden). (War Office). (TOPOGRAFISCHE DIENST). (*Departement van Oorlog*).

Topographical Bureau and Military reconnoitring Service, belonging to the corps of military Engineers (1853—1874) — Established as Topographical Service 1874.

**Present Staff.** Chief: Colonel H. J. K. SCHUITENVOERDER — and a staff of 37 officers, 42 civilians, 94 sergeants and 5 recruits and 492 natives.

*Sections: a. Head Office* (Batavia) with: Cartographic Section (Geographer: P. J. B. VAN KESSEL); Instrument Factory; Map Office; Reproduction Establishment; Library. — *b. Triangulation Brigade* (Chief: Prof. Ir. J. H. G. SCHEPERS); Revision Brigades: West Java at Bandung, Central Java at Magelang, East Java at Malang; Training-Brigade and -school at Malang; Surveying Brigades at Padang (Sumatra), Macassar (Celebes), Pangkalpinang (Bangka), Medan (Sumatra); Detachment Bali and Lombok at Mataram (Lombok); Detachment for Revenue Survey at Macassar (Celebes); Detachment for Agricultural Survey at Padang (Sumatra); id. at Balige (Sumatra).

**Scope.** 1. Triangulation and survey of the Archipelago. *a.* Geodetical and astronomical observations; *b.* Survey of Bali, Lombok, Bangka, West Coast of Sumatra, East Coast of Sumatra and Celebes & Dependencies; *c.* Revision and partial resurvey of Java; *d.* Compilation of sketch- and general maps and the generalizing of all available mapping-material; *e.* Survey for landrevenue, tax-assessment and agriculture — 2. Reproduction of maps. — 3. Assistance to expeditions and scientific institutions.

**Publications**: *a.* Jaarverslag van den Topografischen Dienst (Annual Report of the Topographical Service), 1905-hodie — *b.* Verhandelingen van den Topografischen Dienst, Topographical Service essays on different subjects.

## d. Geology and Volcanology.

### 7. GOVERNMENT GEOLOGICAL SURVEY (Bandung).
(*Department of Government Industries*).

### (OPSPORINGSDIENST DIENST VAN DEN MIJNBOUW).
(*Departement van Gouvernements Bedrijven*).

**History.** Established (1852) at Buitenzorg as Dienst van het Mijnwezen (Mining Service). Headquarters moved to Batavia (1866), to Bandung (1924). For more than half a century, this department did all kinds of work; it was charged with the supervision of private mines, geological and mineral survey work, the management of government mines and government mining-exploration; it had the public water supply from artesian wells entrusted to its care, etc.

Scientific geological work on a large scale was begun in the eighties, mainly under Dr. R. D. M. VERBEEK and other well-known mining engineers. A preliminary geological survey of Java was finished in 1891. For more than 30 years after this date attention was centred on the islands outside Java (Buitenbezittingen, outer Possessions); but a short time ago the service began its regular fieldwork in Java again.

In 1922 the Geological Survey ("Opsporingsdienst") was organized as an autonomous division of the Mining Service (now called "Dienst van den Mijnbouw"), under the Department of Government Industries.

**Scope.** A comprehensive geological and mining survey of the Dutch East Indies, including the study of its mining and quarrying possibilities, its palaeontology, petrography and mineralogy, and hydrology. For Sumatra a systematic survey of the soil for agricultural purposes has also been included in the scope of the Geological Survey.

A special branch gives advice to other public services, municipalities, and private companies desiring geological advice or local investigation for engineering purposes, such as irrigation schemes, water supply, road and railroad construction, the application of water power, quarries and industrial purposes of all kinds.

**Present Staff.** Director: Ir. A. C. De Jongh; assistant-director: Ir. W. F. F. Oppenoorth — *a. Office of the director; museum and laboratories:* Geologists: Ir. G. Pott, Ir. J. H. L. Zermatten, Ir. J. Westerveld, Ir. G. van Kooten — Conservator and mineralogist: Ir. J. E. Loth — Petrographer: Dr. Ir. W. F. Gisolf — Chemist: Ir. H. W. V. Willems — Editor of publications: Ir. C. W. A. P. 't Hoen — *b. Geological Survey Party for Java.* Acting superintendent: Ir. W. F. F. Oppenoorth — Geologists: Ir. A. Chr. D. Bothé, Ir. C. ter Haar, Ir. W. C. Benschop Koolhoven, Dr. C. E. A. Harloff, Ir. G. ter Bruggen, ..... — *c. Geological and Soil Survey Party for Sumatra.* Superintendent: Dr. J. Zwierzycki — Geologists: Dr. Ir. R. W. van Bemmelen, Dr. J. Cosijn, Dr. Ir. J. M. W. Nash, Tj. L. Reitsema, Dr. J. F. van Tuyn, ....., ..... — Pedologists: Dr. J. M. K. Szemian, ....., ..... — *d. Geological consulting office for engineering works.* Geologists: Ir. L. J. C. van Es, Ir. Th. Nelissen — *e. Volcanological Survey and Observation Service.* Geologists: Dr. Ch. E. Stehn, Dr. M. Neumann van Padang — *f. West Borneo Reconnaissance Party.* Geologist: Ir. L. H. Krol — *g. East Borneo Reconnaissance Party.* Geologists: Dr. Ir. C. P. A. Zeylmans van Emmichoven, Ir. J. G. H. Ubaghs, ....., ..... — *h. East Celebes Reconnaissance Party.* Geologist: Dr. H. E. G. Straeter, ....., ..... — *i. Palaeontological Laboratory.* Palaeontologists: Prof. Dr. H. Gerth, Dr. J. H. F. Umbgrove, Dr. Ir. Tan Sin Hok, ....., ..... — Staff geologists on home leave: Ir. C. A. de Jongh, Dr. G. L. L. Kemmerling, Dr. K. A. F. R. Musper.

**Publications**: *a.* Jaarboek van het Mijnwezen in Nederlandsch-Indië (Yearbook of the Mining Service in the Dutch East Indies), I—LVIII, 1872-hodie. 1. Algemeen Gedeelte (General Part), contains the annual report of the Mining Service and the mineral industry in the Dutch East Indies for the current year; 2. Verhandelingen (Proceedings), contains the memoirs of the Geological Survey and some records of technical work done by the Mining Service — *b.* Geologische Overzichtskaart van den N.I. Archipel, in 21 bladen. Schaal 1 : 1.000.000 (General Geological Map, with explanatory notes 21 sheets). Issued: Sheets I, II, VII—IX, XIII—XVII, XX, XXI — *c.* Verslagen en Mededeelingen betreffende indische delfstoffen en hare toepassingen (Reports about minerals and their applications), Nos. 1—19, 1911-hodie — *d.* Vulkanologische en Seismologische Mededeelingen (Volcanological and Seismological Information), Nos. I—10, 1918-hodie — *e.* Wetenschappelijke Mededeelingen (Scientific Information) Nos. 1—9, 1924-hodie, containing mainly palaeontological subjects — *f.* Bulletin of the Netherlands Indies Volcanological Survey, appearing monthly, since November 1927 (From 1921—1925: Vulkanologische Berichten I—LII) — *g.* "De Mijningenieur". Issued monthly (since 1919) by the Society of Government Mining Engineers and Geologists.

The publications mentioned sub c—d—e are to be had of Messrs. Kolff & Co., Booksellers, Weltevreden. The "Jaarboek van het Mijnwezen" (a 1 and 2) can be obtained from the "Depot van Leermiddelen", Weltevreden; the parts of the geological map (b) are included, but are also sold separately by the "Topografische Dienst", Weltevreden. In Holland all publications can be obtained from Martinus Nijhoff, The Hague.

## e. Geophysics.

### 8. ROYAL MAGNETICAL AND METEOROLOGICAL OBSERVATORY (Batavia—Weltevreden).

*(Navy Department).*

### (KONINKLIJK MAGNETISCH EN METEOROLOGISCH OBSERVATORIUM)

*(Departement der Marine).*

Established 1866.

**Present Staff.** Director: Dr. J. Boerema, Prof. of Physics in the Medical Faculty at Batavia — Subdirector: Dr. S. W. Visser — Scientific collaborators: Dr. H. P. Berlage and Dr. C. A. van den Bosch.

*Meteorological Observations.* Observations about temperature, humidity, sunshine, wind and other meteorological elements are made at the Observatory and at a number of stations distributed over the whole Archipelago. The results of the observations have been compiled by Dr. C. Braak in a treatise "The Climate of the Dutch East Indies".

Rainfall observations are made at more than 3200 stations, the results are published in monthly ans annual volumes; moreover nearly 50 selfrecording raingauges are in operation. A rainfall atlas of Java, containing the average monthly and yearly rainfall, prepared by Dr. J. Boerema has appeared as "Verhandeling No. 14". "Verhandeling No. 15" is a treatise by Dr. J. Boerema on the extension of rainshowers at Batavia, and in "Verhandeling No. 18" the different types of rainfall occurring in the Dutch East Indies are discussed by the same author. A publication on the east-monsoon forecasting in Java by Dr. H. P. Berlage has appeared as "Verhandeling No. 20".

Observations about the intensity of the radiation of the sun have been made by Dr. J. Boerema by means of a silverdisk pyrheliometer and a Michelson's pyrheliometer. Besides records are obtained by selfrecording instruments of the sun's radiation and of the total radiation (sun and sky) on a horizontal surface. Preparations are being made to obtain records of the total radiation on Mount Pangerango (3018 m) and at Tjibodas (1410 m).

*Seismological Observations.* The Observatory has two Wiechert seismographs of which the horizontal pendulum has a mass of 1000 Kg., the vertical seismograph one of 1300 Kg.

Earthquakes are also recorded at Ambon by a similar horizontal Wiechert seismograph and the erection of a third instrument of this type at Medan is being prepared.

In addition to the large seismographs, two Bosch pendulums record at the observatory, and small seismographs are found on Merapi and Papandajan, two active volcanoes.

Two treatises on the distribution of earthquakes in the Archipelago by Dr. S. W. Visser have appeared as Verhandelingen No. 7 and No. 9; a treatise on Long Waves as Verhandeling No. 16. Moreover an annual report about seismic activity in the Archipelago is puhlished in the „Natuurkundig Tijdschrift voor Ned. Indië".

*Magnetic Observations.* Absolute observations of the magnetic elements are made at the Observatory, eye-readings are made only during night-hours; the self-recording instruments, now at Buitenzorg, will have to be removed to Kuiper, a small island in the Bay of Batavia. The last magnetic survey of the Archipelago was discussed by Dr. S. W. Visser in Verhandeling No. 13.

*Aerological Observations.* Observations about windforce and direction in the

higher air layers are made at Batavia, Bandung, Surabaja, Kupang, Makassar, Medan and in the Sangih-islands.

Tide tables for several harbours are published.

A treatise on Monsoon-currents in the Java Sea has been published as Verhandeling No. 19 by Dr. H. P. BERLAGE.

Wireless time signals are given by means of the powerful radio-station at Malabar (cf. No. 10).

**Publications**: *a.* Observations at the Royal Magnetical and Meteorological Observatory (Landsdrukkerij, Weltevreden), I—XLVI, 1876—1923 — *b.* Observations made at sub-stations in the Dutch East Indies (Landsdrukkerij, Weltevreden), I—VIII, 1913—1918 — *c.* Regenwaarnemingen in Ned.-Indië (Rainfall observations the Dutch East Indies) — *d.* Seismogical Bulletin, 1910-hodie — *e.* Vulkanische Verschijnselen en Aardbevingen in den Oost-Indischen Archipel waargenomen (Volcanological Phenomena and Earthquakes, observed in the Dutch East Indies) published in the „Natuurkundig Tijdschrift voor Nederlandsch-Indië" (cf. No. 45) — *f.* Verhandelingen (Proceedings) — *g.* Observations météorologiques (see sub No. 12).

## f. Technical Sciences.

### 9. GOVERNMENT SERVICE FOR WATERPOWER AND ELECTRICITY (Bandung) (cf. No. 1c).

(*Department of Government Industries*).

**(DIENST VOOR WATERKRACHT EN ELECTRICITEIT).**

(*Departement van Gouvernements Bedrijven*).

Established 1917, when the Bureau of Waterpower of the State Railway Department (1912) was incorporated with the section for Electricity of the Department of Government Industries (1913).

**Present Staff.** Chief: Prof. Ir. N. VAN DE LEY — 3 Sections: *a. Electrotechnical:* Chief: Ir. C. D. VOLKER. Projects, concessions, advice, legislation, electrotechnical laboratory (Ir. H. A. G. HAZEU) — *b. Hydrotechnical:* Chief: W. BLASER. Projects, plant and constructions, concessions, advice, legislation, waterpower survey — *c. Operative:* Chief: Ir. V. L. A. RAZOUX SCHULTZ. Hydro-electric services in West-Java.

**Scope.** The economical supply of energy and an appropriate use of the waterpower of the country. Promotion of the industrial development of the country, and of the government-industries in particular.

**Publications**: *a.* Annual reports — *b.* Annual reports of the waterpower survey (Gauging-station Records) — *c.* Mededeelingen (Bulletin) no. 1 on waterpower regulations, no. 2 on electricity regulations, no. 4 on standardization of electric pressures — *d.* Miscellaneous publications (see annual reports).

Published in English: Present and Future Utilization of Hydraulic Power in the "Dutch East Indies" (reprinted from Sluyters' Monthly East Indian Magazine Vol. 1, No. 6, Nov. 1920) — The Waterpower and Electrical Service (Handbook of the Netherlands East-Indies) — Transactions of the First World Power Conference (Different articles on Water-Power in the Netherlands East-Indies).

### 10. MALABAR RADIOTELEGRAPHIC STATION (Bandung).

(*Department of Government Industries*).

**GOUVERNEMENTS RADIO DIENST.**

(*Departement van Gouvernements Bedrijven*).

Established as a separate section of the Government Post, Telegraph and Telephone Service in 1920, though the first wireless station had been built as early as 1911

(Sabang), and had been followed by three other stations Situbondo (1912), Kupang (1912) and Amhon (1913).

**Present Staff.** *a. Radio Section Technical department.* Chief: Ir. A. J. H. VAN LEEUWEN. Assistant: Ir. N. H. VERDAM. Office of the Chief: management and extension of the Radio Service in the Dutch East Indies, and supervision of the following divisions 1. Radio stations near Bandung. Chief: Ir. L. WAASDORP. Transmitting stations Malabar, Tjililin, Dajeuh Kolot and Tjimindi, and receiving station Rantja-Ekek. 2. Technical Service and traffic management. Experiments and research. Chief: Ir. W. F. EINTHOVEN. Experiments for the technical improvement of the stations near Bandung. Special experimental installations, laboratory for research, testing and measurement. 3. Preparation, construction, installation and management of radio stations in other parts of the Archipelago. Chief: Ing. J. SANDERS.

*b. Department for Telegraphy and Radiotelegraphy.* Head of the department: H. L. G. AERNOUT. Assistants: Inspectors A. VAN DOOREN and H. A. BIER. Administrative supervision of the telegraph- and wireless services in the Netherlands Indies and with foreign countries, management of the telegraph service at home and with foreign countries, computation of rates, finances, statistical data and information.

**Results.** The establishment of the radio station at Malabar with long wave transmission (1917). The first mountain-antenna was built here. Dr. Ir. DE GROOT first built an experimental receiving installation at Tjankring near Bandung (1917) which received messages from many European and American Wireless stations. In August 1917 the building of the Malabar radio station was begun, and March 1918 the first messages were transmitted. Since then, Malabar has been continually extended. The second transmitting-station Tjililin was finished in August 1918. As a result of many experiments in several places, two new receiving stations, Rantja-Ekek and Padalarang were installed in 1924; the latter was abandoned after a few years (1928). The number of messages sent has increased continually. At present Malabar sends messages to and receives messages from Holland and other European countries, America, Pacific stations, French Indo China, the Philippines and other stations in the Dutch East-Indies. The Radio laboratory was established in 1919 and has since been extended considerably. Short-wave transmission experiments were begun in 1925 at the laboratory. Short wave transmission was begun at Tjililin in the same year and afterwards in several other places. In 1927 short wave radio telephony by means of transmitters was begun at the laboratory and at Malabar. Meanwhile the wireless service has been considerably extended. At present there are 28 transmitting- and receivingstations, and 30 which are receiving-stations only.

## 11. GOVERNMENT LABORATORY FOR THE TESTING OF MATERIALS (Bandung) (cf. No. 1b).

*(Department of Public Works).*

## (LABORATORIUM VOOR MATERIAAL-ONDERZOEK).

*(Departement der Burgerlijke Openbare Werken).*

Established in 1909.

**Present Staff.** Director: Prof. Ir. W. VAN ALPHEN DE VEER — *a. Mechanical Section:* Chief: Ir. M. P. L. G. HANSEN. Machinery for the mechanical and microscopical testing of metals, stone, concrete, road materials etc. — *b. Chemical Section:* Chief: Ir. W. J. TH. AMONS. Routine-work and study of paints, bituminous material, mortars, feed-water, mineral oils, combustibles, metals etc.

**Publications:** Verslagen van het Departement der B.O.W. (Reports of the Department of Public Works).

# III. BIOLOGICAL SCIENCES.

## a. Botany and Zoology.

### 12. GOVERNMENT BOTANIC GARDENS (Buitenzorg).

(*Department of Agriculture, Industry and Commerce*).

### ('S LANDS PLANTENTUIN).

(*Departement van Landbouw, Nijverheid en Handel*).

Established 1817.

**Scope**: The Study of biology generally, importation and distribution of valuable botanical and economical plants, preservation of the beauties of nature and offering opportunities to study to foreign biologists.

**Present Staff.** Director: Dr. W. M. DOCTERS VAN LEEUWEN, Professor of Botany in the Medical Faculty at Batavia (Weltevreden) — *a. Laboratory and Office of the Director.* Studies on galls and biology in general, new flora of Krakatau; assistant: Dr. F. W. WENT, plant physiology; conservator: Miss C. C. REIJNVAAN — *b. Treub-Laboratory.* Chief: Dr. F. C. VON FABER. Plant-physiology; 6 tables available for foreign investigators — *c. Herbarium and Museum for Systematical Botany.* Chief: Dr. J. G. B. BEUMÉE, Plant taxonomy in general; herbalists: R. C. BAKHUIZEN VAN DEN BRINK, Verbenaceae, Ebenaceae; Dr. K. BOEDIJN, Fungi; Dr. B. H. DANSER: Polygonaceae, Nepenthaceae, Loranthaceae, Genetics, plant-geography; Dr. H. J. LAM; Sapotaceae, Sarcospermaceae, Boerlagellaceae, Burseraceae, plant-geography; Dr. F. VAN SLOOTEN: Dipterocarpaceae, Flacourtiaceae, Combretaceae, Stylidiaceae; Dr. C. G. J. VAN STEENIS, Bignoniaceae, plant-geography; conservator: Mrs. M. LANG; assistant-conservators: Mrs. F. TERLAAK and W. J. D. TOOROP — *d. Botanic Gardens, Buitenzorg* (250 m) area about 80 hectares. Chief curator: P. M. W. DAKKUS, assistant-curator: M. L. A. BRUGGEMAN — *e. Botanic Garden, Tjibodas* (1410 m), mountain-garden and forest reserve up to 3018 m, area about 1200 hectares, assistant-curator: C. VAN WOERDEN; guesthouse and laboratory with 3 tables available for foreign investigators — *f. Botanic Garden and Forest Reserve Sibolangit,* near Medan (Sumatra, East-Coast) (500 m); area about 150 hectares — *g. Zoological Museum and Laboratory.* Chief: Dr. K. W. DAMMERMAN; mammals and zoogeography; zoologists: Dr. H. H. KARNY: insects; H. C. SIEBERS: birds; taxidermist: P. F. FRANCK — *h. Marine biological Laboratory and Aquarium* (Batavia). Chief: Dr. H. C. DELSMAN, Professor of Zoology in the Medical Faculty, Weltevreden: fishes; zoologists: C. J. BOTTEMANNE; Dr. J. D. F. HARDENBERG; Dr. J. VERWEY, technologist: Ir. B. MARCUS; 5 tables available for foreign investigators — *i. Phytochemical Laboratory.* Chief: .....

**Publications**: In addition to several series of publications that were begun and stopped again in course of time, a large number of separate papers, pamphlets and books (such as Floras) have been issued by the Government Botanic Gardens or by the Department of Agriculture, Industry and Commerce (formely Department of Agriculture), most of them about zoology, botany and agriculture. We shall here mention only the most important periodicals of former periods together with those issued at present. Those readers who take an interest in botanical literature are referred to the article on "Botanische Literatuur" in the „Encyclopaedie van Nederlandsch-Indië".

The most important earlier periodicals are: *a.* Icones bogorienses I—IV (400 pl.), 1897—1914, containing plates and descriptions of new or noteworthy plants — *b.* Flore de Buitenzorg I—VI, 1898—1922, containing monographs on Orchidaceae,

Algae, Musci, Pteridophyta and Myxomyceta — *c.* Mededeelingen uit 's Lands Plantentuin (Publications of the Government Botanic Gardens), Nos. I—LXXV, 1884—1904 — *d.* Mededeelingen uitgaande van het Departement van Landbouw (Publications of the Department of Agriculture), Nos. I—18, 1905—1914, *c* and *d* containing, besides numerous studies on various botanical, zoological, pharmacological and agricultural subjects, also the well-known series "Bijdragen tot de Kennis der Boomsoorten van Java" by Dr. S. H. KOORDERS and Dr. TH. VALETON (Contributions to the knowledge of the various kinds of trees of Java) — *e.* Bulletin du Departement de l'Agriculture aux Indes Néerlandaises, Nos. 1—47, 1906—1911, containing papers on various subjects (vide enumeration in Bull. du Jard. Bot. de Buitenz., Ser. III, Vol. I, 1918) — The present series of the Bulletin du Jardin botanique de Buitenzorg was preceded by the following series: *f.* Serie I. Bulletin de l'Institut botanique de Buitenzorg, Nos. 1—22, 1898—1904, containing papers on various subjects (vide enumeration in Serie III, Vol. I, 1918); *g.* Serie II. Bulletin du Jardin botanique de Buitenzorg, Nos. 1—28, 1911—1918 — *h.* Contributions à la Faune des Indes Néerlandaises I, 1915—1918 (continued as "Treubia", see below) — *i.* Icones Fungorum Malayensium; Abbildungen und Beschreibungen der Malaiischen Pilze, by Dr. C. VAN OVEREEM († 1927) and Prof. Dr. J. WEESE, fasc. 1—16, 1923—1926 — *j.* Observations Météorologiques, Institut botanique de l'Etat de Buitenzorg, 1901—1915.

At present the Government Botanic Gardens publish the following periodicals, etc.: *a.* Annales du Jardin botanique de Buitenzorg (E. W. BRILL, Leiden), I—XXXVIII, 1876-hodie (Vol. XXXVIII, 1927); Editors: W. DOCTERS VAN LEEUWEN and CH. BERNARD; chiefly papers on physiology, anatomy, biology, embryology and geography of plants (enumeration in 4th Suppl., 1918) — *b.* Bulletin du Jardin botanique de Buitenzorg (Archipel Drukkery, Buitenzorg), Série III, 1—X, 1918-hodie; Suppl. I, 1928; Editors: Prof. Dr. W. DOCTERS VAN LEEUWEN, Dr. F. C. VON FABER and Dr. J. G. B. BEUMEE; papers on taxonomy of plants — *c.* Treubia, Receuil des Travaux zoologiques, hydrobiologiques et océanographiques (Archipel Drukkerij, Buitenzorg), I—X, 1919-hodie; Editors: Prof. Dr. W. DOCTERS VAN LEEUWEN, Dr. K. W. DAMMERMAN and Prof. Dr. H. C. DELSMAN — *d.* Arbeiten aus dem Treub-Laboratorium, I, 1927 — *e.* Handboek van de Flora van Java (Handbook for the Java flora) by C. A. BACKER, issued fasc. I—III, 1924-hodie — *f.* Guides to the Gardens — *g.* Seed catalogues.

## 13. MUSEUM AND INQUIRY OFFICE FOR ECONOMIC BOTANY (Buitenzorg).
(*Department of Agriculture, Industry and Commerce*).

## (MUSEUM, TEVENS INFORMATIE-BUREAU VOOR ECONOMISCHE BOTANIE).
(*Departement van Landbouw, Nijverheid en Handel*).

This institution, which at one time formed part of the Division for Commerce of the Department of Agriculture, Industry and Commerce, forms collections relating to economic botany, and gives information on this subject. The Museum contains samples of products of the most important cultivations, samples of the raw and finished product as it appears in the market as well as the different stages of its manufacture. In this connection we mention fibres, material for basket work, tanning materials, essential and other oils, gums, resins and coagulated latex (rubber and gutta-percha), medicinal plants, foodstuffs, samples of wood and other materials for building purposes etc. It also contains models and moulds, pictures of the most important installations and implements used in manufacturing the above-mentioned

products together with detailed data and statistics with regard to the market values, etc.

In 1905 the Museum found accommodation in a special building belonging to the Department of Agriculture; it was opened to the public January 29th, 1908.

Between 1913 and 1917, K. HEYNE, Head of the Museum, compiled and published a work in 4 volumes entitled "De Nuttige Planten van Nederlandsch-Indië" (The useful plants of the Netherlands Indies) which is at the same time meant to be a synthetic catalogue of the collections found in the Museum. This book attracted so much attention that the first edition of the first volume which appeared in 1913, was very soon exhausted. The 2nd, 3d, and 4 th volumes appeared in 1916—1917, while in 1922 a more complete edition of volume 1 was published. The book, which was originally meant to be a descriptive catalogue of the different vegetable-products of the Netherlands Indies, was the precursor of a new work, complete in every respect, which the author intended to publish at a later period. This stupendous task, which required a special study and a close investigation into the origin of the vernacular names at the same time, occupied nearly all of the time of the Head of the Museum during the years after 1918. This second revised and enlarged edition (published in 3 volumes by the Department of Agriculture, Industry and Commerce) appeared in 1927.

In the same year the author retired and returned to Europe. A new Head of the Museum has not yet been appointed; Dr. J. STROOMBERG, Chief of the Division of Commerce, is now charged with the supervision of the collections belonging to the Museum.

On December 20th, 1927, Dr. C. G. G. J. VAN STEENIS was appointed herbalist of the Museum.

## b. Medical Sciences.

### 14. PUBLIC HEALTH SERVICE (Batavia—Weltevreden).

*(Department of Education and Public Worship).*

### (DIENST DER VOLKSGEZONDHEID).

*(Departement van Onderwijs en Eeredienst).*

**a. Medical Laboratory** (Geneeskundig Laboratorium) (Batavia—Weltevreden). Established 1888.

**Present Staff.** Director Col. S. L. BRUG, A. M. S. — *a. Bacteriological Department.* Dr. M. SARDJITO, Dr. P. PEVERELLI — *b. Malaria Department.* Chief: Dr. E. W. WALCH; Dr. R. SOESILO, Dr. C. SCHUURMAN — *c. Chemical Department.* Chief: Dr. W. F. DONATH, Jhr. Dr. P. J. TEDING VAN BERKHOUT.

**Scope.** The laboratory is destined for research work and routine work. Subjects of research: bacteriological, parasitological, epidemiology of malaria, foodstuff researches, especially with regard to vitamines. The malaria department may be considered as the central malaria institute for the whole archipelago.

**Publications** mostly in: *a.* Geneeskundig Tijdschrift voor Nederlandsch-Indië (cf. No. 55) (Journal of Medicine for the Dutch East Indies). Founded 1851; Issued: Every two months; Editor: Dr. Ch. W. F. WINCKEL — *b.* "Mededeelingen van den Dienst der Volksgezondheid" (Communications of the Public Health Service) 1912—1925 entitled: "Mededeelingen van den Burgerlijken Geneeskundigen Dienst" (Communications of the Civil Medical Service). Founded 1912; Issued: from three to five times a year; Editors: J. HUIZINGA, S. L. BRUG, P. H. OLIVIER —

**b. Water Analyses and Depuration Laboratory** (Proefstation voor Waterzuivering) (Meester CORNELIS, near Batavia). Established 1923.

**Present Staff.** Chief: Dr. Ir. C. P. MOM; Staff: Ir. O. H. VAN DER HOUT,

Ir. N. D. R. Schaafsma; Analysts: Ang Goan Hoat, C. de Roode, Mohamed Arif Gelar Radja Penghoeloe, Raden Soekendar.

**Scope.** *a.* Research work on drinking water — *b.* Research work on the depuration of ground- and surface waters for drinking-water-supply — *c.* Research work on the depuration of sewage — *d.* Chemical and bacteriological investigations for the establishment of drinking-water-supplies and sewage purification works; general chemical and bacteriological advice in questions of management of same. **Results.** Contributions to the hygienic technology of drinking-water and sewage, derived from laboratory experiments etc. in Java, Sumatra, Borneo and Celebes.

**Publications**: Individual papers by members of the staff.

**c. Medical Colleges** (cf. No. 3).

1. STOVIA (**S**chool tot **O**pleiding van **I**ndische **A**rtsen = School for the training of Indian Physicians) Weltevreden (Batavia). Founded 1851.

Average number of pupils during the last three years 285.

Now that the new "Geneeskundige Hoogeschool" has been opened the STOVIA will close when the present students graduate. In 1928—1929 still 144 (among whom 3 female) students are registered, 132 of whom are destined for Government service. Among those 144 there are 20 Europeans, 11 Chinese, 8 students from the Minahasa (N. Celebes), 5 from Amboina, 61 Javanese and 39 from Sumatra.

Lessons are at present given by the following professors of the Faculty of Medicine (cf. No. 3): Messrs. Mysberg, De Waart (acting director of the college) Bonne, Roll, Radsma, De Langen, Lesk, Boerma and Wulfften Palthe and further by special STOVIA teachers: Dr. P. Peverelli, Parasitology and Hygienics; Dr. M. Th. Koks, Pharmacology and Pharmaceutics; Dr. P. H. Olivier, Clinic and Policlinic: Dr. R. Dj. Asikin, Propaedeutical clinic; Dr. R. D. Kandou, Chemical and Microscopical Diagnostics; Dr. H. H. Th. Bor, Dentistry; Dr. J. A. Verbunt, Dermatology and Venereal Diseases; Sister M. Kenninck, Wound-dressing and Sick-nursing.

2. NIAS (**N**ederlandsch-**I**ndische **A**rtsenschool = School for physicians in the Dutch East Indies), Surabaja. Founded 1913.

A leaving-certificate of a secondary school with a three years' course is required to be admitted to the school. The pupils of the N. I. A. S. study about 8 years and after a final examination they receive the title of Indian doctor. The medical branches which are taught are the same as those taught in the Universities with this difference only that the study of the pupils is regularly controlled by the staff of the school. The number of pupils is 280. Up to 1928 inclusive 65 qualified pupils had left the school.

**Present State.** Staff: R. J. F. van Zeben, Director, Microscopical anatomy; Dr. A. Rant, Botany; Dr. D. de Visser Smits, Zoology; Dr. S. Koopal, Chemistry; J. H. P. de Kruyff, Physics; S. Schregardus, Dutch and Mathematics; M. J. Maters, English; P. Smith, German; Dr. H. W. Lubberhuizen, Anatomy; Dr. J. W. Best, Physiology; Dr. H. Müller, Pathology, Pathological Anatomy and Forensic Medicine; Tj. Wieberdink, Surgery; E. G. E. Croin, Gynaecology and Midwifery; Dr. M. Schöppe, Dentistry; Dr. M. Soewarno, Diseases of the eye; Dr. W. C. Aalsmeer, Medicine; Dr. R. Soetomo, Skin diseases; Dr. J. van Slooten, Bacteriology and Hygiene; Soerjatin, Nursing; T. L. Ongkiehong, Pharmacy and Pharmacognosy; A. de Timmerman, Neurology and Psychiatry; H. H. Noosten, Diseases of the nose, throat and ear; Dr. W. F. A. Tamm, Pharmacology.

Graduates of the STOVIA and the NIAS are qualified to practise all branches of medicine and surgery in the Netherlands Indies.

**d. Government Vaccine and Pasteur Institute** (Landskoepokinrichting en Instituut Pasteur (Bandung). Established 1891.

**Scope.** *a.* preparation of (buffalo) lymph for 10—12 million inoculations yearly — *b.* preparation of (monkey) virus fixe for treatment of about 600 patients yearly — *c.* preparation of therapeutic and prophylactic vaccines (against typhoid, cholera, dysentery, etc.) about 1000 litres yearly — *d.* preparation of therapeutic sera (against tetanus, diphtheria, dysentery, snakes, etc.) about 400 litres yearly — *e.* laboratory for general (clinical-bacteriological) examination.

**Publications**: Annual Reports and papers by several members of the staff (NIJLAND, BORGER, JEANNE V. D. HOVEN VAN GENDEREN, KIRSCHNER, OTTEN).

### 15. NETHERLANDS INDIES CANCER INSTITUTE (Bandung).
(*Private*).

### (NEDERLANDSCH-INDISCH KANKERINSTITUUT).

Established January 1st, 1922.

**Committee**: president, .....; vice-president, Prof. H. M. NEEB; secretary, C. DONKER VAN HEEL; assistant-secretary, Dr. A. J. F. OUDENDAL; treasurer, W. F. ZUUR; members: Prof. N. J. A. F. BOERMA; Prof. Dr. C. BONNE; Prof. Dr. J. CLAY (memb. Exec. Comm.); P. R. W. VAN GESSELER VERSCHUIR; H. H. KAN; Lt. Gen. H. L. LA LAU; Dr. G. F. MERZ; Maj. Gen. H. C. NAUTA; Dr. J. OFFRINGA; Dr. W. J. ROOS VAN DEN BERG (memb. Exec. Comm.); CH. J. I. M. WELTER; TJ. WIEBERDINK; Ir. J. E. A. VON WOLZOGEN KÜHR.

**Scope**: The institute aims at collecting and elaborating informations concerning the cancer problem, especially in the Netherlands Indies: further it purposes to come into relation with societies and associations with similar aims and to promote the study of the cancer problem.

**Results**: The institute has therefore erected and maintains a Cancer Research Laboratory (director Dr. A. J. F. OUDENDAL, c/o Juliana Ziekenhuis, Bandung), for which a large building has been planned. This laboratory which works in close collaboration with the Faculty of Medicine at Batavia (No. 3), will then have the disposal of a large main building and two separate pavilions, one for chemical and one for serological investigations. The complete designs of those buildings may be shown at the Fourth Pacific Science Congress to those interested in cancer investigation.

**Publications**: *a.* Jaarverslagen (Annual Reports), 1922-hodie — *b.* Various publications of the members of the staff.

## c. Veterinary Sciences.

### 16. CIVIL VETERINARY SERVICE (Buitenzorg).
(*Department of Agriculture, Industry and Commerce*).

### (BURGERLIJKE VEEARTSENIJKUNDIGE DIENST).
(*Departement van Landbouw, Nijverheid en Handel*).

**a. Veterinary Institute** (Veeartsenijkundig Instituut). Established 1908.

**Present Staff.** Director: Dr. C. BUBBERMAN, D. Vsc. — *a. Section for general diagnosis.* Bacteriologist: F. C. KRANEVELD, vet. surgeon. Examination of pathological material supplied by government officials. Studies of infective diseases and parasitic

blood diseases (surra, piroplasmosis, anaplasmosis). Experiments on immunity in anaplasmosis, osteomyelitis bacillosa bubalorum, tenacity of bacillus bubalisepticus — *b. Section for serological diagnosis, glanders and tuberculosis.* Bacteriologist: L. W. M. LOBEL, vet. surgeon. Serodiagnosis of glanders and contagious abortus. Preparing of malleine and tuberculine. In 1927 19.596 c. c. malleine and 17.718 c. c. tuberculine were distributed. Experiments on immunity in glanders — *c. Section for the preparing of controlled antisera and vaccines.* Bacteriologist: Prof. Dr. F. L. HUBER, D. Vsc. Preparation of antisera against haemorrhagic septicaemia in the buffalo, anthrax, blackleg, infectious abortus, fowl-cholera and vaccines against haemorrh. septic. (agressin), anthrax (spores-vaccine), blackleg (filtrate), infect. abortus, fowl-pox. In 1927: 1.452.500. c.c. antisera and 717.130 c.c. vaccines were distributed. Experiments on immunity in haemorrh. septic. and infect. abortus — 4. *Section for economical veterinary zoology.* Parasitologist: Dr. J. B. KRIJGSMAN. Determination of internal and external parasites. Studies of the biology of surra-transmitting insects (principally of tabanids), as well the transmission itself and of the Lyperosia exigua and their natural enemies — 5. *Section for poultry diseases.* Bacteriologist: Dr. W. K. PICARD, D. Vsc. Examination of material handed in by poultry-keepers and government officials. Investigation into all kinds of diseases prevalent among indigenous poultry. Experiments on immunity in pseudo-fowlpest, a pest-like sickness, which works great havoc among the fowls.

**Publications.** (*a*) Veeartsenijkundige Mededeelingen van het Departement van Landbouw, Nijverheid en Handel (Veterinary Information published by the Department of Agriculture, Industry and Commerce) (Buitenzorg), Nos. 1—62, 1909-hodie — (*b*) Nederlandsch-Indische Bladen voor Diergeneeskunde (Netherlands Indies Veterinary Journal) (cf. No. 57) (Archipel drukkerij, Buitenzorg), Vol. I—XLIV, 1885-hodie (Vol. I—XXXII, 1885—1917, entitled: Veeartsenijkundige Bladen voor Nederlandsch-Indië).

**b. Experiment Station for Cattle-breeding.** Established 1927.

Director: Dr. J. MERKENS, teacher in the Veterinary College (No. 16 *d*).

**Scope.** Experiments will be made on cross-breeding with European and native sheep, goats and pigs.

**c. Experiment Station for Poultry-breeding.** Established 1927. Director: P. H. J. GASILLE.

**Scope.** Improvement of native poultry strains.

**d. Netherlands Indies Veterinary College** (Nederlandsch-Indische Veeartsenschool, Buitenzorg). Established 1907.

Staff: Principal Dr. H. J. SMIT — Sections: 1. *Chemistry and Physical knowledge*, chief: Ir. Y. D. B. BUISMAN; 2. *Anatomy and Physiology*, chief: Dr. F. W. K. DU MOULIN. 3. *Pathological anatomy*, chief: Dr. H. J. SMIT; 4. *Clinical Instruction*, chief: Dr. J. WITKAMP; 5. *Contagious diseases and Bacteriology*, chief: Dr. J. B. DOUWES; 6. *Zootechnic*, chief: Dr. J. MERKENS.

This is a training-college for Indian Veterinary Surgeons.

A leaving certificate of a school for secondary instruction with a 3 years' course or any similar certificate is required for admission to the college.

The Veterinary College is a secondary trade school, whose main object is to give its pupils the necessary training for veterinary practice.

The curriculum of students who mean to become veterinarians is four years.

**Publications** appear in the "Nederlandsch-Indische Bladen voor Diergeneeskunde" (cf. No. 57).

# IV. AGRICULTURAL SCIENCES.

## a. Education.

### 17. SECONDARY AGRICULTURAL COLLEGE (Buitenzorg).

*(Department of Agriculture, Industry and Commerce).*

**(MIDDELBARE LANDBOUWSCHOOL).**

*(Departement van Landbouw, Nijverheid en Handel).*

Established 1903; reorganized 1913.

After a three-years' training in agriculture or forestry, the pupils of this college can find employment on estates as staff-assistants and enter the Forestry Service or the Service for Agricultural Extension Work.

*Board of Curators:* Prof. Dr. G. VAN ITERSON, President; A. D. H. BOSCH, Ch. G. S. BRAAT, E. HALEWIJN, V. Ahn; P. PIETERSE, secretary — *Staff:* Dr. VALETON, principal, Zoology, plant-morphology; T. E. C. W. CANTER VISSCHER, rural economics, cultivation of cinchona, coffee, tea, cacao; W. H. E. SCHREUDER, plant-anatomy and physiology, fungi and genetics, cultivation of indigenous crops, rubber, coconut-tree, oil-palm; H. J. V. SODY, agronomy, general plant-breeding, cultivation of tobacco, fibre-plants, sugar); Dr. Ir. A. THORENAAR, forestry; K. VAN DER VEER, physics, mechanical soil cultivation, cultivation of rice; Dr. P. H. WIRTH, chemistry; C. J. BAKKER, gymnastics; G. J. E. BOSWINKEL, hygenics; J. B. BOUMANS, fencing, optional; K. KOOY, carpentry; W. H. TH. MARCUS, engineering; Dr. F. W. K. DE MOULIN, animal husbandry; H. J. PREIS, surveying; R. SADARSAN, Javanese; M. SOEKARIA SASMITA, Sundanese; Mr. J. G. DE BOER, political science; H. BOSSCHER, engincering.

Number of students: about 130, of whom nearly 1/3 are Europeans and Indo-Europeans, 1/12 Chinese and the others Natives.

## b. Government Institutions.

### 18. GENERAL EXPERIMENT STATION FOR AGRICULTURE (Buitenzorg).

*(Department of Agriculture, Industry and Commerce).*

**(ALGEMEEN PROEFSTATION VOOR DE LANDBOUW).**

*(Departement van Landbouw, Nijverheid en Handel).*

Established 1918.

**Scope.** Research-work and measures in behalf of those branches of agriculture for which no special experiment-station exists, hence especially for native agriculture.

Director: Dr. Ir. L. G. DEN BERGER, General manager.

**a. Institute for plant diseases.** (Instituut voor Plantenziekten) (Buitenzorg). Established 1912. Zoological Laboratory, Botanical Laboratory, Plant Quarantaine Service.

**Staff.** Director: Dr. S. LEEFMANS — 1. *Zoological Laboratory:* Dr. S. LEEFMANS, pests of coconut, coffee, fruit-tree; Dr. P. VAN DER GOOT, pests of rice and leguminous crops; L. G. E. KALSHOVEN, forest-entomology; Jhr. W. C. VAN HEURN, field-rats;

Dr. A. REYNE, scale insects of coconut in Celebes and the Moluccas; Dr. C. J. H. FRANSSEN, Pest of onions and Palaquium — 2. *Botanical Laboratory:* Miss Dr. C. M. DOYER, mycologist — 3. *Plant Quarantaine Service:* J. VAN DER VECHT. Entomologist.

**Scope.** Scientific investigations into the pests and diseases of native crops, and the means to combat them.

**Results.** A successful campaign against *Brachartona* by a special system of cutting infected fronds — A successful campaign against the white rice borer (*Scirpophaga*) by regulating the sowing-time — Combating the potato-tubermoth (*Phtorimea*) by covering potatoes with earth during storage — Study of the teak-termite (*Calotermes*) and of the methods to combat field-rats — Introduction of parasites and predators from Java into Celebes to combat *Aspidiotus destructor, Aleurodicus destructor, Ceroputo spinosus.* — Study of methods to combat slime diseases (*Bacillus solanacearum*) of peanuts and potatoes.

**Publications**: *a.* Mededeelingen van het Instituut 1912—1914: van de Afdeeling: 1914—1916: van het Laboratorium voor Plantenziekten (Publications of the Institute for Plant Diseases) (Landsdrukkerij, Weltevreden) Nos. 1—73, 1912—1927. Containing papers on economic entomology and mycology. *b.* Korte Mededeelingen van het Instituut voor Plantenziekten (Short essays etc.) (Archipel Drukkerij, Buitenzorg) Nos. 1—6, 1926—1928. Containing preliminary papers and notes on economic entomology. All this publications are discontinued (cf. Note at the end of this paragraph).

**b. Agricultural Institute** — Chief: Dr. P. VAN DER ELST — 1. *Agricultural Subdivision.* Fertilizing- and irrigation-experiments; agricultural implements; testing of plant varieties etc. Chief Ir. A. WULFF; agriculturists: Ir. H. F. WATERSCHOOT: Ir. H. TULNER — 2. *Subdivision for seedbreeding of annual crops.* Selection and breeding of plant-material of annual crops. Chief: L. KOCH; botanist: Dr. I. BOLDINGH, especially the selection of maize. Agriculturist: Ir. J. G. J. VAN DER MEULEN. Seed-garden at Muara, manager: M. VAN DER MEER. Experiment Garden at Buitenzorg (Tjikeumeuh), manager: V. Ch. G. Ch. DE BEAUVESIER WATSON — 3. Subdivision for seedbreeding of perennial crops. Selection and breeding of plant-material of perennial crops. Chief: H. DE VEER; agriculturist: Ir. W. K. HUITEMA. Experiment Garden at Buitenzorg (Cultuurtuin, Tjikeumeuh), manager: W. M. VAN HELTEN. Government Rubber-seed garden at Tjibinong, curator: J. J. BLANS.

**Laboratories**: 1. *Botanical Laboratory.* Studies of bacterial, fungus- and other non-zoological diseases, physiology of foodplants. Chief: Dr. P. VAN DER ELST; mycologist Miss Dr. C. M. DOYER, Dr. Ir. H. R. A. MULLER; botanist: Dr. H. TOXOPEUS — 2. *Chemical Laboratory.* Investigation into the composition of irrigation water, soil, fertilizers and other agricultural products. Chief: Dr. C. VAN ROSSEM; chemist: F. W. WEBER — 3. *Microbiological Laboratory.* Studies of soil bacteriology and of microbiological problems concerning agriculture. Chief: J. GROENEWEGE — *d. Laboratory for Pedology.* Studies of soil-science; soil-survey. Chief: Dr. Ir. J. TH. WHITE; petrographist: Dr. E. E. SCHEIBENER; soil scientist: Ir. J. A. VAN BEUKERING, Ir. H. J. TE RIELE.

**Publications.** The publications of the above institutes, now amalgamated with the General Experiment Station for Agriculture, are discontinued from 1924 and will henceforth appear under the following titles: *a.* Mededeelingen (Communications) van het Algemeen Proefstation voor den Landbouw, Nos. 1—26, 1919-hodie — *b.* Korte mededeelingen (Short Communications) van het Algemeen Proefstation voor den Landbouw, Nos. 1—5, 1926-hodie — *c.* Korte berichten (Pamphlets) van het Algemeen Proefstation voor den Landbouw, Nos. 32—54, 1923-hodie.

## 19. FORESTRY RESEARCH INSTITUTE (Buitenzorg).

(*Department of Agriculture, Industry and Commerce*).

## (PROEFSTATION VOOR HET BOSCHWEZEN).

(*Departement van Landbouw, Nijverheid en Handel*).

Established 1913.

**Present Staff.** Director: Dr. R. WIND; — *a. Section of wood-technology*. Chief: A. TH. J. BIANCHI. Collaborator Miss Ir. G. M. C. VROLIJK. Identification of tropical woods with a pocketlens; investigations on the mechanical, physical and chemical properties, the microscopic structure, the durability, seasoning and preservation of wood; rules for the inspection of timber; grouping of the different kinds of wood with respect to durability and value (in collaboration with the section for botanical and wood-technical exploration); distribution of authentic specimens of wood-investigations of minor forest products; extension service — *b. Section for botanical and wood-technical exploration of forests*. Chief: Dr. F. H. ENDERT. Collaborator: Ir. L. VERHOEF. Collecting of botanical material and authentic wood-samples of the principal trees of the Archipelago; collecting of data about range, frequency and vernacular names of trees and about the use and durability of wood; identification of the species using sterile material — *c. Section for the investigation into the regeneration of other species than teak*. Chief: Ir. H. W. JAPING. Sylvicultural investigations into the most important kinds of trees for industrial purposes, for the production of the mountain-forests; distribution of seeds — *d. Section for the investigation into the regeneration of teak and forest-protection*. Chief: Dr. H. M. J. HART. Sylvicultural investigations into the regeneration of teak and its principal associates; distribution of seeds; forest protection against fires, trespassing and injury except by insect-pests and fungoid diseases — 5. *Section for thinnings- and yieldcapacity*. Chief: Forest-officer H. E. WOLFF VON WÜLFING. Collaborator: Ir. H. P. UITENBOGAARD. Investigation of the yield in timber, value of teak and other species; methods of measuring crops and increment, modes of treatment, calculation of yieldtables etc.

**Publications**: *a.* Mededeelingen van het Proefstation voor het Boschwezen (Publications of the Forestry Research Institute) Nos. 1—21, 1916-hodie — *b.* Korte Mededeelingen (Short essays) van het Proefstation voor het Boschwezen, Nos. 1—15, 1921-hodie — *c.* Tectona, issued by the Society of higher Forestry Officers in the Netherlands Indies, 1—XXII, 1908-hodie. (cf. 59).

## 20. GOVERNMENT RUBBER PLANTATION LABORATORIES (Buitenzorg).

(*Department of Agriculture, Industry and Commerce*).

## (s'LANDS CAOUTCHOUCBEDRIJF).

(*Departement van Landbouw, Nijverheid en Handel*).

Established 1911 as a part of the Forestry service; since 1918 under the supervision of the Director of the Department of Agriculture, Industry and Commerce.

Director: A. VAN GELDER — *a. Agricultural Research Department* (Buitenzorg). Field experiments and selection of rubber, oil palm, kapok and coffee. Chief: Dr. J. G. J. A. MAAS; Assistant Ir. W. C. VAN HEUSDEN. — *b. Laboratory of the Government Gutta-Percha Estate "Tjipetir"* (Tjipetir). Study of gutta-percha, cultivation, selection, manufacture and technology. Chief: H. VAN LENNEP, chemist: Dr. H. R. BRAAK.

## 21. AGRICULTURAL SERVICE, DEPARTMENT OF AGRICULTURE, INDUSTRY AND COMMERCE (Buitenzorg).

## (LANDBOUWVOORLICHTINGSDIENST VAN HET DEPARTEMENT VAN LANDBOUW, NIJVERHEID EN HANDEL).

**a. Scientific Commissioner for freshwater fishery.** — Dr. A. C. F. L. BUSCHKIEL.

**Scope.** This officer who has started his work in May 1928, has to direct investigations on freshwater fishery problems, to be started in ponds, lakes and rivers in the Netherlands Indies; moreover, he has to prepare, in concert with the chief of the Agricultural Service, the personnel necessary for those investigations.

**b. Horticultural Service** (Tuinbouwvoorlichtingsdienst).
Established in 1915.

**Present State.** Chief: J. J. OCHSE — Curator of the Experiment Garden at Pasuruan: G. J. HARMSEN — Curator of the Experiment Garden Ragunan: M. M. MAGIELSE.

**Scope and results.** This service which aims at producing superior material of fruit trees, disposes of several experiment gardens, viz.: 1. For miscellaneous fruit trees a garden at Ragunan, Pasar Minggu (near Batavia), 120 bahu's (1 bahu = 7096.5 m/. = 1.75 acres) with 80 planned more bahu's. For all fruit trees except mangga and djeruk — 2. For mangga (Mangifera indica) a garden at Pasuruan, 30 bahu's, with branch gardens at Pamekasan (Madura) (6 bahu's), Surakarta (Solo) (5 bahu's) and Cheribon (7 bahu's) — 3. For djeruk (Citrus-species) a garden at Punten (near Malang) (5 bahu's).

Sounding experiments on locally dominant stocks: searching for effective budding methods and for stock material resistent against diseases; providing native horticulturists with improved planting material. Mr. MAGIELSE has devised a very efficient budding method by budding superior mangga material on stocks which have previously been selected and disseminated on the spot.

Some of the scientific problems, such as phytopathological, genetical and selectional problems, are carried out by officers of the General Experiment Station for Agriculture (No. 18).

**Publications.** Several publications, mostly by J. J. OCHSE, have been issued by the Native Reading Office (No. 40), both in Dutch and in native languages: also some by the Department of Agriculture, Industry and Commerce.

**c. Division of Agricultural Economics.**
Established 1 January 1918.

**Staff.** Acting chief: M. B. SMITS — Assistant: A. LUYTJES.

**Scope**: Studies of the economy of different branches of agriculture; agricultural exploration; calculation of the cost of European estates: study of future possibilities of native rubber export and advice on export-tax on rubber and licence to be given to rubbermills in accordance with the rubber mill-decree; valuation of plantings and waste grounds on private property; advice to the Director of Agriculture, Industry and Commerce on rural questions, taxes, labour conditions, etc.

**Publications**: Several papers on plantingconditions (1924 Dr. N. R. PEKELHARING), native rubber cultivation (1925—1927, A. LUYTJES) and oilpalm cultivation (1927, A. LUYTJES) published by the Department of Agriculture, Industry and Commerce.

c. Private Experiment Stations.

# GENERAL ORGANIZATION OF PRIVATE EXPERIMENT STATIONS,

by Dr. O. DE VRIES.

The Experiment Stations for the large European crops in the Netherlands Indies were founded in a more or less haphazard way, whenever the need arose. Gradually the original, small, local stations were reorganized and larger units were formed. Centralization was carried furthest by the sugar interest, which now has one big Experiment Station at Pasuruan (No. 32), co-operating with the central organization the Sugar Syndicate (Algemeen Syndicaat van Suikerfabrikanten in Nederlandsch-Indië) which studies economical and political questions, forms a central selling-organization etc. The big central Experiment Station consists of three more or less independent divisions for agricultural, chemical and engineering work; the local advisory work is done by a staff of field officers (local agents) stationed in the different sugar-planting centres.

The development for tobacco has taken place along other lines. Tobacco being a fancy product in which quality plays the principal part, the interests of growers in different districts are not the same and a combination of Experiment Stations is out of the question. In Deli East Coast of Sumatra the Experiment Station (No. 34) forms part of the big local organization of tobacco-growers (Deli Planters Vereeniging) which has also divisions for the recruiting of coolies, hospitals, economic and other interests. In the "Vorstenlanden" (Central-Java) the Tobacco Experiment Station (No. 29) is run by a separate Association, in Besuki (East Java) (No. 33) it has been combined with the hill-crops.

The so-called mountain-crops or hill-crops (rubber, coffee, tea, cinchona etc.) formerly had a number of experiment stations in different combinations. A central organization having been established for Java and South Sumatra (Algemeen Landbouw Syndicaat or General Agricultural Syndicate), these stations are now being reorganized, the idea being to create one central station for each crop to control the work and to undertake the responsibility for the general programme, while the other stations, each of them „central" for another important crop act as local representatives (supervision of field experiments, local advisory service etc.).

This somewhat complicated organization is necessitated by the very large area over which the mountain crops are scattered; supposing

that Buitenzorg was Paris, Malang would be found near Rome and Djember somewhere near Naples, so that the organization of the A.L.S. covers an area extending from Central and South England (South Sumatra) to France, Switzerland and Italy (East Java). A special system of cooperation — regular exchange of copies of reports and important letters; regular conferences of general-managers and of the technical staff — had to be developed to bring this organization to its present efficiency.

In Besuki, where none of the big crops predominate, the local wants have been met by a smaller station at Djember (No. 33) for tobacco, rubber and coffee, which pays special attention to such rubber problems as are connected with combined rubber and coffee-planting and the East Java climate (a long dry season).

The East Coast of Sumatra forming a separate unit in many respects, a complete Experiment Station (Algemeen Proefstation der A.V.R.O.S., No. 35) for all hillcrops has been established at Medan: this station of course cooperates with the Java stations.

In addition to these general Experiment Stations a certain number of scientific or advisory services have been established by the larger groups of planting interests, to solve their special problems and improve the technical control of their plantations.

Interchange of ideas and a spirit of friendly cooperation are furthered and kept up by the "Vereeniging voor Proefstation Personeel" (Association of the staffs of Experiment Stations which counts among its members officials of the staffs of the various institutes, as well as of the corresponding divisions of the Department of Agriculture, and which at its annual meetings discusses all matters of general agricultural and scientific interest.

## 1. WEST-JAVA.

### 22. GENERAL TEA EXPERIMENT STATION (Buitenzorg). (ALGEMEEN PROEFSTATION VOOR THEE).

Established 1882 as a part of the Department of Agriculture, its working-expenses being defrayed by subscriptions of teaplanters. From 1902 until 1926 it worked for its own account though occupying the buildings of the Department of Agriculture. In 1926 it became an independent private institute under the supervision of the "Algemeen Landbouw Syndicaat" (Batavia), and has its headquarters in its own building.

**Staff.** Director: Dr. J. J. B. Deuss, Dr. C. P. Cohen Stuart, botanist-selectionist; Dr. A. Steinmann, mycologist; A. J. Garretsen, Head agricultural department; A. A. M. N. Keuchenius and Ir. P. M. H. H. Prillwitz, agronomists; Ir. F. C. van Eekhout, chemist; M. Neumann, assistant.

**Scope.** The Tea Experiment Station studies all problems connected with the

culture and manufacture of tea; laboratory-experiments, experiments in its own experiment garden and on tea-estates; advisory service etc.

**Publications**: *a.* "Mededeelingen van het Proefstation voor Thee" (Publications of the Tea Experiment Station) published at odd times, Nos. 1—100, 1908—1927 — *b.* "De Thee", a Quarterly Journal (1920—1927) — *c.* In 1927 these two were combined and now form a series of publications called "Archief voor de Theecultuur" (Tea Cultures Archives) in which everything is published that is in the interest of the culture and manufacture of tea — *d.* Publications of the station also occur in „De Bergcultures" (Mountain Cultures), a weekly paper issued by the "Algemeen Landbouw Syndicaat" (General Agricultural Syndicate) — *e.* A few other publications are: Gedenkboek der Ned.-Ind. Theecultuur 1824—1924 (Memorial book of the Dutch East Indies Tea Culture) — Handelingen van het Theecongres met Tentoonstelling 1924 (Proceedings of the Tea Congress and Exhibition) — Handleiding voor de Theebereiding (1922) (A Manual of Tea manufacture) — Handboek der Javaansche Theeonkruiden (1924) (A Handbook of the Java Tea weeds) by C. A. Backer and Dr. D. F. van Slooten.

## 23. RUBBER EXPERIMENT STATION (Buitenzorg). (PROEFSTATION VOOR RUBBER).

Established January 1926 by the combination of three smaller experiment stations, viz. the Central Rubberstation (established June 1915; preparation and testing of rubber), the West Java Rubber Experiment Station (established June 1915; agricultural and botanical work) and the Physiology Fund (started January 1918; study of the physiological part played by latex). The Experiment Station for Rubber is the central rubber research institution for Java and South Sumatra and cooperates with the Besuki Experiment Station (No. 33), the Malang Experiment Station (No. 31) and the local advisers in Central Java and South Sumatra, all of them belonging to the organization for rubber of the "Algemeen Landbouw Syndicaat" (General Agricultural Syndicate).

**Staff.** Dr. O. de Vries, director-chemist; Dr. T. A. Tengwall, sub-director and botanist (soils, field experiments on planting distance, tapping etc., yield-statistics); Dr. W. Bobilioff, physiologist (physiological part played by latex and tapping, anatomy); Dr. R. Riebl, chemist (special types of rubber, factory equipment); Mrs. N. Beumée—Nieuwland, chemist (chemistry of latex and coagulation, analyses of coagulants and other chemicals); Ir. M. Vrolijk, agriculturist (experiment Garden Tjiomas 50 hectares; field experiments on tapping and green manuring); Dr. G. M. Kraay, chemist (rubber testing by vulcanization, viscosity, plasticity etc., methods of preparation on estates); Ir. J. S. Vollema, agriculturist (manuring, cultivation and other problems); Ir. F. W. Ostendorf, agriculturist (yield- and agricultural-work on improvement of planting-material); Dr. A. Pfältzer, phytopathologist (study and combating of diseases and pests); H. Ramaer jr., geneticist (botanical-work on planting-material and breeding); H. J. de Ruyter, secretary.

**Scope.** The work done at the station comprises all points that may further and improve the rubber-planting industry. Scientific research, routine testing, field work and practical advice work. A special system of close cooperation with the stations in other parts of the island has been developed.

**Results.** In botanical- and field work the search for better planting material engages the attention of the staff above anything else. Both buddings (clones from superior trees) and seed (superior mothers, artificial pollination) are being studied and promise a considerable increase of production. Field experiments on manuring

and green manures (of which many new species have been introduced of late years) are made on a large scale, together with soil analyses. Other problems, such as tapping systems, planting distance and thinning, rejuvenation etc. are being studied diligently.

An extensive investigation has been made into the anatomy of Hevea, especially the bark, and into the physiological part played by latex the results of which have been partly published ("Anatomy and Physiology of Hevea brasiliensis" by Dr. W. BOBILIOFF, Part I). Attention is paid also to different diseases and a review is given in "Diseases and Pests of Hevea brasiliensis" by Dr. A. STEINMANN (Archipel Drukkerij, Buitenzorg, 1927).

About 4000 samples of latex (rubber contents etc.), 5000 samples of rubber (vulcanization tests, viscosity, plasticity, chemical composition etc.) and others are regularly tested every year. Research work on methods of testing and on the influence of physiological factors on the properties and composition of the rubber has been done on a large scale (published in "Estate Rubber, its Preparation, Properties and Testing" by Dr. O DE VRIES, 1920, RUYGROK & Co. Batavia). Research work on the coagulation phenomena and on the factors that govern plasticity is still in progress.

**Publications**: *a*. Archief voor de Rubbercultuur in Nederlandsch-Indië (Archives for Rubber Culture in the Dutch East Indies) (Buitenzorg and Batavia), 1—XII, 1917-hodie — *b*. Mededeelingen van het Rubberproefstation West-Java (Publications of the Rubber Experiment Station West-Java), Nos. 1—62, 1913—1925 — *c*. Korte mededeelingen (Short Essays) van het Centraal Rubberstation, Nos. 1—30, 1916—1925 — *d*. Mededeelingen (Publications) van het Centraal Rubberstation, Nos. 1—54, 1916—1925 — *e*. Mededeelingen van het Proefstation voor Rubber (Publications etc.), 1—35, 1926-hodie — *f*. Korte Mededeelingen (Short Essays) van het Proefstation voor Rubber, Nos. 1—32, 1926-hodie — *g*. Mededeelingen uit de Praktijk (Publications on practical subjects), Nos. 1—6, 1925-hodie — *h*. Circulars, notes and shorter articles in "Bergcultures" (Batavia) and other technical journals — *i*. Scientific papers in European and American rubber-journals — *j*. Annual reports, containing a survey of experiments in hand and results obtained to date.

### 24. MALABAR TEA EXPERIMENT STATION (Malabar—Bandung). (THEEPROEFSTATION MALABAR).

A small private experiment station, founded by the manager of the tea estate Malabar, the late Mr. K. A. R. BOSSCHA.

**Publications** in the "Mededeelingen van het Proefstation voor Thee" (cf. No. 22), Nos. XXIV, XXX, XXXVII, XLV, XLVII, by K. A. R. and J. BOSSCHA, BERNARD, BRZESOWSKY, DEUSS and MAURENBRECHER.

### 25. CINCHONA EXPERIMENT STATION (Tjinjiruan—Pengalengan—Bandung). (PROEFSTATION VOOR KINA).

This originally formed part of the Government Cinchona Estate (formely "Gouvernements Kinacultuur") founded 1854. In January 1927 this connection was severed and since then the station has worked as a private institution.

**Present Staff.** Dr. M. KERBOSCH, director-chemist; Dr. C. SPRUIT, botanist; W. VAN DORSSEN, chief analyst; Miss E. VAN DER TAS, analyst; A. J. VAN ZWET, agriculturist.

**Scope.** Agricultural, botanical and chemical investigations about Cinchona culture.

**Results.** *Cinchona Ledgeriana Moens* has proved to be by far the best quinine producer — Root-diseases may be prevented by using *Cinchona succirubra Pavon* as a stock. — Damage caused by *Corticium salmonicolor* may be restricted within certain limits by vegetative reproduction of little sensitive strains — Damage caused by *Helopeltis Antonii* may be restricted in the same way — Selection increased the production of *Cinchona Ledgeriana* by 40—60 % (seed reproduction) — A technical method for the quantitative analyses of alcaloids in Cinchona-bark was worked out — Selection with vegetative reproduction increased the production by 80—100 % — The same grounds can always be used for Cinchona cultivation as a consequence of selection, vegetative reproduction and manuring — The yield may be checked scientifally by means of a special method.

**Publications**: *a.* Jaarlijksch Bericht aangaande den Toestand der Kinacultuur op Java (Annual Report on the State of Cinchona Culture in Java) 1862—1865 — *b.* Verslag omtrent de Kinacultuur op Java (Report on Cinchona Culture in Java) 1865—1874 — *c.* Verslag van de Gouvernements Kina-onderneming (Report of the Government Cinchona Estate) 1875-hodie — *d.* Mededeelingen van het Gouvernements Kina-proefstation (Publications of the Government Cinchona Experiment Station) I—IX, 1912—1925 — *e.* Cinchona, Archief voor de Kinacultuur (Cinchona, A journal of Cinchona Culture) I—VI, 1924-hodie.

## 26. ADVISORY SERVICE OF THE COMPANY FOR THE EXPLOITATION OF THE PAMANUKAN- AND TJIASEM- ESTATES (Subang).

## (ADVIESDIENST VAN DE MAATSCHAPPIJ TER EXPLOITATIE DER PAMANOEKAN- EN TJIASEM-LANDEN).

**Present State.** C. E. VAN DER ZIJL, agricultural adviser; J. E. A. DEN DOOP, adviser of agricultural experiments at the sisal-hemp-estate, Sukamandi; H. J. TH. LIGTVOET, assistant.

**Scope and Results.** This advisory service comprises the different cultivations, started by the above-mentioned Company. It aims principally at collecting data by means of experiments and elaboration of statistical materials, in order to render the advices wanted as effective as possible. Especially the following general problems are in the course of investigation: differences regarding productive capacity between different varieties and their suitability for the product desired; influence of ground-tillage, manuring, plantation-distance, etc. on the yielding-capacity. Experiments have been started concerning these problems; some of them have already been finished and their results utilized, such as those regarding tapioca, sisal-hemp, rubber, sugar and rice.

(*Note.* Several cultivation companies have scientifically skilled advisers in their service. Generally speaking, their work is somewhat different from the common work at experiment stations, though, as in the present case, it may develop into that direction. In general such advisory services are considered to be lying outside the scope of the present Conspectus. However, I included a short communication on the above, because an excursion of the Fourth Pacific Science Congress visits its estates. H. J. L.).

### 27. EXPERIMENT STATION FOR THE JAVA SUGAR INDUSTRY, BRANCH STATION CHERIBON, (PROEFSTATION VOOR DE JAVA-SUIKERINDUSTRIE, ONDERAFDEELING CHERIBON).

A branch station of the Agricultural Section of the Experiment Station for the Java Sugar Industry at Pasuruan (No. 32). Established 1910. Mainly for investigations into local agricultural and phytopathological questions and cane-breeding.

**Present Staff.** Director: Miss Dr. G. WILBRINK; botanical assistant: Miss Dr. P. C. BOLLE; chemical assistant: Miss A. E. BERKHOUT.

**Publications** in the "Archief voor de Suikerindustrie in Nederlandsch-Indië" (Archives for the Sugar Industry in the Dutch East Indies). (cf. No. 32).

## 2. Central Java.

### 28. CENTRAL JAVA EXPERIMENT STATION (Salatiga). (PROEFSTATION MIDDEN JAVA).

Established 1896 as an Experiment Station for cocoa. In 1905 it was reorganized and received the name of "General Experiment Station", for all cultures except sugar. This Experiment Station existed till 1911, when the organization "Proefstation Midden-Java" was founded; since that time the institute has principally studied all problems regarding the cultivation of coco, coffee and rubber.

**Scope.** When the mountain cultivations were organised again and when the General Agricultural Syndicate was founded in 1926 the Central Java Experiment Station remained a separate organization; it gives information and advice on coffee, cocoa, rubber, tea and various other smaller crops (coca, capoc etc). For rubber, tea and coffee the local work is done in cooperation with the special experiement stations for these cultures; for the various other smaller crops in cooperation with the General Experiment Station (No. 18).

**Present Staff.** Dr. J. J. B. DEUSS, director; J. TH. DE HAAN, agronomist especially for coffee and other cultures; J. W. VAN HOUTEN, agronomist, especially for rubber; H. A. HOEZOO, secretary.

**Publications**: *a.* Mededeeling van het Proefstation voor Cacao (Publications of the Cocoa Experiment Station), Nos. 1—10, 1901—1904 — *b.* Mededeelingen van het Algemeen Proefstation (Publications of the General Experiment Station), containing reprints from: *c.* Cultuurgids (Culture Guide), I—XIII, 1899—1911 — *d.* Several contributions in the "Archief voor de Rubbercultuur" (Archives for Rubber Culture) and in the publications of the Tea- and Coffee Experiment Stations — *e.* In 1927 the "Archief voor Cacoa en andere kleine cultures" (Archives for cocoa and other small cultures) was started, which is published at odd times.

### 29. EXPERIMENT STATION FOR "VORSTENLANDEN" [1]) TOBACCO (Klaten, Djokjakarta). (PROEFSTATION VOOR VORSTENLANDSCHE TABAK).

Established 1898.

**Present Staff.** Dr. Ir. D. TOLLENAAR, director botanist; plant-breeding, cytology, phytopathology — P. M. BARTELS, agriculturist; general research-work on plant-breeding, phytopathology and manuring — Dr. Ir. C. COOLHAAS, chemist-bacteriologist.

[1]) Vorstenlanden = Principalities; semi-independent Sultanates in Central Java.

**Scope.** Research work in behalf of the tobacco estates in Surakarta and Djokjakarta.

**Publications**: Mededeelingen van het Proefstation voor Vorstenlandsche Tabak (Publications of the Experiment Station for "Vorstenlanden" Tobacco) Nos. 1—60, 1913-hodie (with summaries in English).

### 30. SUGAR EXPERIMENT STATION OF THE UNITED KLATEN PLANTATION COMPANY Ltd. (Klaten).

### (SUIKERPROEFSTATION VAN DE N.V. VEREENIGDE KLATENSCHE CULTUURMAATSCHAPPIJ).

Established 1891.

Originally this experiment station dealt also with tobacco and indigo, the interests of these crops, however, were, in 1900, provided by two separate experiment stations at Klaten, one for tobacco (cf. No. 29) and one for indigo (discontinued).

**Present State.** Ir. W. CHR. BEDDING, director-chemist — Chemical Department, Ir. W. CHR. BEDDING, Ir. O. VAN BLOMMESTEIN, Ir. J. J. HOOGLAND — Technical Department (est. 1925). Ir. P. WITKAMP and a bachelor of mechanics — Agricultural Department (est. 1928). Ir. F. J. BOOGERD.

**Scope and Results.** Analyses of different factory products; daily milling reports, compiled into comparative milling results. Under the directorship of Ir. BOOT a sulfitation-process was invented. Ir. DE HAAN invented the carbonatation-process for manufacturing a superior white sugar.

The experiment station deals with all questions concerning the nine factories and controlls the materials ordered on behalf of them, such as lime, sulfur, coke, filter-cloth, manuring chemicals, etc.

**Publications**: Publications appear in the "Archief voor de Suikerindustrie in Nederlandsch-Indie" (cf. No. 32).

## 3. East Java.

### 31. MALANG EXPERIMENT STATION (Malang).

### (PROEFSTATION MALANG).

Founded July 1911 by the proprietors of agricultural estates (chiefly those interested in coffee and rubber) in the Residencies of Madiun, Kediri, Pasuruan and Surabaja (East Java).

On the occasion the reorganization in January 1926, the "Algemeen Landbouw Syndicaat" (General Agricultural Syndicate of Batavia) undertook to bear the entire expenditure of the Experiment Station, and the Experiment Station at Malang was made the central institution for the coffee-planting industry in the Netherlands Indies.

**Present State.** Dr. A. J. ULTÉE, director-chemist — Dr. W. BALLY, botanist for coffee — Dr. H. BEGEMANN, entomologist for coffee — Dr. C. KNAUS, chemist for coffee and rubber — Dr. M. HILLE RIS LAMBERS, selectionist for coffee — C. C. AMENT and Ir. TH. RAAFF, agriculturists.

**Scope.** The task of the Experiment Station is research work in behalf of coffee-planting in the Netherlands Indies. „Arabica" coffee, however, in which practically only a few estates in the Residency of Besuki are interested is beyond its scope.

The Experiment Station has its own building, laboratories, a garden for research work of about $3^3/_4$ acres ($1^1/_2$ hectares) and an experiment garden of 247 acres (100 hectares).,

The Experiment Station also gives advice to the coffee and rubber estates within its sphere. This takes place by regular visits to all these estates, by delivering lectures, by technical advice in writing, by circulars and publications.

**Publications.** The results of this scientific research work are published in the "Mededeelingen van het Proefstation Malang" ("Publications of the Malang Experiment Station"), which are not for sale, and of which more than 60 booklets have appearded (1911-hodie).

The greater number of these articles also appear in the "Archief voor de Koffiecultuur" (Archives for Coffee Culture) (1925-hodie) or in the "Archief voor de Rubbercultuur" (Archives for Rubber Culture) (cf. No. 23).

A second group of publications is formed by the "Notulen" (Minutes) of the General Meetings, of which 28 have been issued.

The lectures and other practical information given to the members appear in the organ of the "Algemeen Landbouw Syndicaat" (General Agricultural Syndicate), entitled "De Bergcultures" (Mountain Cultures).

## 32. EXPERIMENT STATION FOR THE JAVA SUGAR INDUSTRY (Pasuruan). (PROEFSTATION VOOR DE JAVA-SUIKERINDUSTRIE).

Established by sugar-cane growers especially to combat the "sereh" disease at Semarang 1885, at Tegal 1886 and at Pasuruan 1887. The station at Semarang was closed 1892, that of Tegal afterwards developed into one for chemistry and engineering, that of Pasuruan remained a botanical-agricultural station. The three were centralized at Pasuruan 1921.

**Present Staff.** Board of Directors: Prof. Ir. E. C. von Pritzelwitz van der Horst (president); Dr. V. J. Koningsberger; Dr. Ir. P. Honig. Central institute: General service, management, archives, library, museum, etc.

*A. Agricultural Department:* research work and advice for the promotion of cane-culture; periodical publications, statistics. Director: Dr. V. J. Koningsberger; sub-director; G. Booberg — *I. Field Service:* Java has been divided into 15 departments of groups, each with its own local agent, a botanist or agriculturist. These agents are the links between the central station and the cane growers. Agrogeological investigations, field-experiments (about 3000 chessboard-experiments yearly), diseases, insect-pests etc. Inspectors: E. Demandt, Ir. J. van Dijk; Chief field-experiment-service .....; Local agents: H. Houwing, D. B. J. Kievits; Dr. J. H. Coert, Ir. A. G. Wethmar, M. Kulescha, H. Altmann, A. W. Schmuziger, Dr. A. Radermacher, Dr. C. van Dillewyn, Dr. A. C. Nieschulz, Dr. P. C. Hart, Dr. R. Brink, E. W. Clason, Dr. G. A. W. van Overbeek de Meyer; Statistics: W. H. Heyligers — *II. Research-work:* Soil-investigation: Miss Ir. G. A. Neeb (analyst: F. Haverkamp); Cane-breeding, selection: Dr. O. Posthumus, C. L. Rümke; Cytologist: Dr. G. Bremer; Botanist (for the study of weeds): C. A. Backer; Physiologist: Dr. T. H. van den Honert; Entomologist: Dr. E. H. Hazelhoff; Phytopathologist: Miss Dr. P. C. Bolle (Cheribon, cf. No. 27).

*B. Engineering Department:* research-work and advice on mechanical, technological and electric installation and the economical use of fuel; periodical publications, statistics. Director: Prof. Ir. E. C. von Pritzelwitz van der Horst — Research-work: Ir. L. D. Teutelink, Ir. den Haan, Ir. H. J. Spoelstra; Consulting engineers: Ir. G. J. Schott, Ir. I. Hes; Survey of milling results and Survey of fuel-economy: G. E. Ferguson; Instrument-shop: J. I. Weber; Work-shop: B. Boulogne.

*C. Chemical Department*: research-work and advice for the improvement of the

product, periodical publications, statistics. Director: Dr. Ir. P. Honig — Analytical section (technical and arbitrary-analysis; methods of analysis): Miss A. Ch. M. van der Kreke, J. G. Smits, P. J. Klokkers, A. L. Kolb — Chemical-technical section (advice and information; factory-research): Ir. J. F. Bogtstra, W. F. Alewyn, P. C. Nicola — Research-work (physical-, colloid-chemistry): Dr. V. Khainovsky, Dr. K. Douwes Dekker — Factory-control: C. E. M. Sylmans, A. F. Spaan.

**Publications**: *a.* Mededeelingen van het Proefstation voor de Java-Suikerindustrie (Publications of the Experiment Station for the Java Sugar Industry), 5th. Ser. Vol. XIX, 1929 — *b.* Short publications and essays in the "Archief voor de Suikerindustrie in Nederlandsch-Indie" (Archives for the Sugar Industry in the Dutch East Indies), from 1893, 4 volumes yearly — *c.* Periodical roneographs on weather-conditions, rainfall, sunshine; milling-results; mill-control; fuel-control; factory-control (1922-hodie).

### 33. BESUKI EXPERIMENT STATION (Djember). (BESOEKISCH PROEFSTATION).

Established 1911, owing to the support of Mr. T. Ottolander.

**Present Staff.** Mag. Scient. Johannes Gandrup, director; Ir. L. R. van Dillen, Chemist; Dr. J. Schweizer, botanist; Dr. J. C. 's Jacob, botanist; G. A. Reydon, agriculturist; Dr. A. Pfältzer, also employed as a phytopathologist at the "Proefstation voor Ruhber" at Buitenzorg (No. 23).

**Scope.** The cultures of Hevea, coffee and tobacco. *Hevea.* Hevea-production in East Java; Hevea mixed with coffee; Hevea-selection; diseases and pests; manuring-experiments; study of latex of individual trees; regeneration of rubber in the trees; tapping-system in connection with wintering — *Robusta Coffee.* Diseases and pests; manuring-experiments; coffee-selection — *Java-Coffee.* Seed-import; selection; hybridization and grafting; diseases and pests; manuring experiments; cover-plants and shadow-trees — *Tobacco.* Diseases and pests; manuring-experiments; selection; curing experiments.

**Publications**: *a.* Mededeelingen van het Besoekisch Proefstation (Publications of the Besoeki Experiment Station) (van Dorp, Soerabaja); Rubber Series Nos. 1—35, 1917—1924; General Series No. 1—43, 1912-hodie — *b.* De proeftuinen voor tabak (The Experiment Gardens for tobacco) published once a year — *c.* Notulen van de Algemeene Vergaderingen van het Besoekisch Proefstation (Minutes of the General meetings) — *d.* Other "Mededeelingen" (Publications) appear in the "Archief voor de Ruhbercultuur in Nederlandsch-Indië" (cf. No. 23), „Archief voor Koffiecultuur in Nederlandsch-Indië" (cf. No. 28) and in "Bergcultures" (cf. No. 22).

## 4. Sumatra.

### 34. DELI EXPERIMENT STATION (Medan, East Coast of Sumatra). (DELI PROEFSTATION).

Established July 1st, 1906; formely a division of 's Lands Plantentuin at Buitenzorg, Laboratory for the study of Deli Tobacco; members of the staff of this Institution were sent to Medan during the planting-season to study tobacco; this was started as early as 1894.

**Present Staff.** Dr. J. Kuijper, botanist-director; Dr. S. C. J. Jochems, Dr. A. Meurs, botanists, selection, phytopathology; J. C. van der Meer Mohr, Dr. J. K. de Jong, entomologists, study of insect-pests, measures of combating same;

Dr. C. H. Oostingh, agrogeologist, soil study; Ir. van der Poel, agronomist, cultivation of tobacco, fertilizer experiments; P. A. Rowaan, chemist, chemical analysis of soils, fertilizers, insecticides; study of drying and curing; B. Ph. M. de Groot, analyst, chief of analytical laboratory; A. R. R. F. Koehn, assistant to botanists for field work; R. Djokojoewono, assistant-analyst; C. H. ten Cate, secretary; R. Noerngali, field assistant.

**Scope.** The study of the cultivation, drying and curing of Deli-tobacco.

The members of the staff act as scientific advisers for the tobacco-cultivation; the problems are studied in the laboratory and on the estates; by visits to the estates the knowledge obtained at the station is communicated to the planters; practical advice to combat pests and diseases and on all agricultural questions. Field experiments are made on the estates; preliminary experiments and careful scientific inspection also in the experimental garden. Statistical figures about rainfall and particulars about the estates are collected.

**Results.** The result of the selection work is a number of pure strains, which are generally cultivated now; the big companies have their own selectionists, working in cooperation with the experiment station. Selection to get strains not liable to "slijmziekte" (bacterial wilt); some good results. *Phytophthora Nicotianae* on the seedbeds is combated by spraying with Bordeaux mixture; this disease hardly ever occurs in fullgrown tobacco. *Pythium spec.* is combated by planting older seedlings and by using better planting methods. Against slijmziekte (*Bacillus solanacearum* E. F. S.) careful inspection of seedlings; seedbeds with one diseased plant are rejected; good drainage and cultivation of the soil; planting of *Mimosa invisa* during a fallow period of 7 years. "Slijmziekte" is now diminishing. The study of mosaic has been taken up; as yet no definite results have been arrowed at Study of the other diseases of unknown or physiological origin. Caterpillars of *Prodenia*, *Heliothis* (*Chloridea*), *Plusia* (*Cynometra*) are combated by spraying and dusting with arsenate of lead; Paris green is hardly used as an insecticide, because it burns easily. Tobacco lice (*Myzus Persicae*) are sprayed with tuba-root-extract (*Derris*), manufactured by the Experiment-station. Atomizers and dusters have been introduced. Destruction of caterpillars damaging the picked tobacco leaves in drying sheds. Fertilizers and insecticides used in tobacco cultivation are certificated by the Station. Fertilizers are used at each estate; the quantity of each kind of manure is determined by field experiments. For the same purpose the soil is studied by the agrogeologist. Drying and curing are studied; the drying process in a Carrier apparatus and also in an experimental drying house, where about 250.000 leaves may be dried at a time. Constancy of environmental conditions is the chief factor to get a good colour; good ventilation is most important; temperature is a matter of secondary importance; a considerable degree of humidity of the air is necessary. Meteorological data are collected.

**Publications** before establishment of the Deli Experiment Station, (1894—1906): *a.* Mededeelingen uit 's Lands Plantentuin (Publications of the Government Botanic Gardens — *b.* Bulletin de l'Institut Botanique de Buitenzorg; Korte Berichten (Short publications) uit 's Lands Plantentuin; all issued by the Department of Agriculture, Buitenzorg (cf. No. 12).

Publications of the Deli Experiment Station: *a.* Mededeelingen van het Deli Proefstation (Publications of the Deli Experiment Station), 1907—1917, 10 volumes; 1917—1929 second series Nos. I—LX; Bulletin van het Deli Proefstation Nos. 1—25, 1914-hodie; Vlugschriften (Pamphlets) van het Deli Proefstation, Nos. 1—50, 1920-hodie; all issued by the Deli Proefstation, Medan.

### 35. GENERAL EXPERIMENT STATION OF THE A. V. R. O. S. (Medan, East Coast of Sumatra).

### (ALGEMEEN PROEFSTATION VAN DE ALGEMEENE VEREENIGING VAN RUBBERPLANTERS TER OOSTKUST VAN SUMATRA).

Established 1917.

**Present Staff.** Director Dr. A. D'ANGREMOND; Secretary CH. H. PARIS. — 1. *Botanical division.* Chief Dr. C. HEUSSER; second botanist: Dr. A. F. FREY; assistant: J. F. J. VAN BIJLEVELT; Hevea selection and plant diseases. Selection garden 100 ha. 2. *Chemical division.* Chief Ir. H. N. BLOMMENDAAL; second chemist Ir. N. H. VAN HARPEN; analyst W. BERTELS. Preparation of rubber, palmoil, tea, etc. — 3. *Agricultural division.* Chief Ir. J. F. SCHMÖLE; second agriculturist Ir. A. KORTLEVE; third agriculturist Ir. H. GONGGRIJP. Tapping experiments with Hevea, manuring experiments, oilpalm selection and other agricultural research work. Experiment garden 900 ha.

**Publications**: Mededeelingen (Publications), Algemeene serie (General series) Nos. 1—33, oilpalm, coffee, tea, covercrops, soil, etc.; Rubber series Nos. 1—59.

### 36. RESEARCH DEPARTMENT OF THE "RUBBER CULTUUR MAATSCHAPPIJ" "AMSTERDAM" (Galang, East Coast of Sumatra).

### (WETENSCHAPPELIJKE DIENST VAN DE RUBBER CULTUUR MAATSCHAPPIJ "AMSTERDAM").

Established 1916.

**Present Staff.** Director: Dr. P. ARENS; botanist for rubber research: Dr. F. ARENS; chemist for rubber research: Ir. VAN DER MEYDEN; scientific adviser for the cultivation of oilpalms: Dr. E. FICKENDEY: technical adviser for the preparation of palmoil: Ir. J. C. VERGEER.

**Scope.** Scientific study of the cultivation and preparation of rubber and oilpalm.

**Laboratories**: 1. Laboratory for Rubber Research at Klein Soengei Karang, Galang, also containing an experimental plant to vulcanize and test rubber — 2. Laboratory at Nykerk Estate, Bah Lias. Problems connected with the preparation of palmoil — 3. Laboratory at Pulu Radja Estate, Tandjongbalai. Problems connected with the cultivation of oilpalms and the preparation of palmoil. Publications only private and confidential.

### 37. PLANTATION RESEARCH DEPARTMENT OF THE UNITED STATES RUBBER PLANTATIONS INC. (Bunut, East Coast of Sumatra).

A private experiment station situated on the estates of the "Hollandsch-Amerikaansch Plantage Maatschappij" (affiliated to the above mentioned company).

**Present State.** Director: J. GRANTHAM, M. A.; chemist: Dr. W. E. CAKE; 2nd chemist: Dr. E. M. Mc COLM; botanist: C. BARCLAY, M.A.; forester: E. E. PROBSTFIELD, M. F.; phytopathologist: Dr. W. H. DE JONG; selection assistant: F. W. DONKERSLOOT.

**Scope.** The work is divided into 2 main sections (1) plantation: investigations into all problems connected with the cultivation of Hevea brasiliensis, and (2) chemical work: investigations into latex and the preparation of crude rubber.

**Results.** The most important progress has been made on the subjects of brown

bast treatment, field experimental methods, manuring, and the development of improved high yielding strains of Hevea by vegetative and seed reproduction.

**Publications**: Results are usually published as Publications of the Plantation Research Department U. S. R. P. Inc. in the "Archief voor de Rubbercultuur in Nederlandsch-Indië" (cf. No. 23) and occasionally in other journals for the rubber industry.

## V. HUMANITIES.

### a. Archaeology.

38. **ARCHAEOLOGICAL SERVICE (Batavia—Weltevreden).**
*(Department of Education and Worship).*
**(OUDHEIDKUNDIGE DIENST).**
*(Departement van Onderwijs en Eeredienst).*

Established 1913.

**Present Staff.** Director: Dr. F. D. K. Bosch; anthropologist: Dr. P. V. van Stein Callenfels; epigraphist: Dr. R. Goris; assistant archaeologist: Dr. K. C. Crucq; official for the monuments in East Java: P. J. Perquin; id. in Central Java: B. de Haan; inspector: P. H. van Coolwijk; photographer: J. J. de Vink; assistant for the Dutch antiquities: N. I. van de Wall (acting).

**Scope.** The Service is entrusted with the care of the ancient monuments of Prehistorical, Hindu, Mohammedan, Dutch, Chinese and Native origin; archaeological research generally.

**Publications**: *a.* Reports of the Archaeological Service 1911—1915. — *b.* Quarterly Reviews 1912—1919 (small size); 1920-hodie (large size). — *c.* "Publications", Part I & II (all published at Batavia by the Royal Batavia Society of Arts and Sciences (No. 39). — *d.* Monographs, Part II: Tjandi Singasari, Part III: Barabudur publ. in the Netherlands. — *e.* Many studies on archaeological subjects have appeared in the Journal and in the Proceedings of the Royal Batavia Society of Arts and Sciences (No. 39).

### b. Ethnology, Law, Linguistics.

39. **MUSEUM OF THE ROYAL BATAVIA SOCIETY OF ARTS AND SCIENCES (Batavia—Weltevreden).**
*(Private Institution, subsidized by the Government).*
**(MUSEUM VAN HET KONINKLIJK BATAVIAASCH GENOOTSCHAP VAN KUNSTEN EN WETENSCHAPPEN).**

Museum and Library (Koningsplein West 12, Weltevreden), established 1864 — Archaeological Collection. Keeper: Dr. F. D. K. Bosch — Historical Collection. Keeper: Dr. F. D. K. Bosch — Enthnographical Collection. Keeper: Prof. Dr. B. J. O. Schrieke; assistant: C. C. F. M. le Roux — Numismatical Collection. Keeper: ..... Library. Librarian: P. Gediking — Collection of manuscripts. Keeper: R. A. Prof. Dr. H. Djajadiningrat; assistant: R. Ng. Dr. Poerbatjaraka.

The building and some of the Collections, (such as the entire archaeological collection) are owned by the Government. The other collections and the library are owned by the society.

### 40. NATIVE READING OFFICE (Batavia—Weltevreden).
*(Department of Education and Public Worship).*
### (KANTOOR VOOR DE VOLKSLECTUUR).
*(Departement van Onderwijs en Eeredienst).*

Established 1917.

**Present Staff.** Chief: T. J. Lekkerkerker; Administrator: J. F. Vos; Chief linguistic Section: Dr. G. W. J. Drewes; Chief translation office: P. F. Dahler; Chief Press Department: J. F. H. A. Later; Chief management of libraries: Miss A. C. J. A. A. van Eekhout.

**Scope.** The original aim was the publication of books for the native population; since 1923 it has also published periodicals.

**Publications**: *a.* Sri Poestaka, a popular-scientific monthly (Malay) — *b.* Pandji Poestaka (an illustrated Malay journal, twice every week) — *c.* Kedjawen (an illustrated Javanese journal, twice every week) — *d.* Weekly survey of the Malay and Malay-Chinese Press — *e.* Volksalmanak (popular almanac), issued every year in Malay, Javanese and Sundanese; 1927: 85.000 copies.

## VI. SOCIETIES.

### 41. NETHERLANDS INDIES SCIENCE COUNCIL (Batavia—Weltevreden).
### (NATUURWETENSCHAPPELIJKE RAAD VOOR NEDERLANDSCH-INDIË).

Established February 28, 1928.

Committee: Prof. Dr. G. van Iterson, president; Prof. Dr. C. D. de Langen, vice-president; Prof. Dr. W. M. Docters van Leeuwen, secretary-treasurer (Buitenzorg); Dr. J. Kuyper and Dr. A. J. F. Oudendal, commissioners — Other members (max. 30): Prof. Dr. J. Boerema, Prof. Dr. W. Boomstra, Prof. Dr. H. van Breen, Col. S. L. Brug, Prof. Dr. J. Clay, Dr. K. W. Dammerman, Prof. Dr. H. C. Delsman, Dr. W. F. Gisolf, E. R. Jacobson, Prof. Dr. B. C. P. Jansen, Prof. Dr. W. A. Mijsberg, Dr. H. ten Oever, Prof. Dr. L. Otten, Prof. Ir. J. H. G. Schepers, Dr. H. J. Smit, Dr. A. J. Ultée, Dr. S. W. Visser, Dr. Ir. J. G. E. G. Voûte, Prof. Ir. C. G. J. Vreedenburgh, Dr. O. de Vries, Ir. H. Witkamp — Members are correspondents of the Royal Academy of Sciences at Amsterdam and scientists appointed by the Netherlands Indies Government on occasion of the Council's establishment.

**Scope.** The Council is an advisory organization to the Government concerning scientific matters. It is, at the same time, a centre of scientific life in this colony (representing, in so far, the Royal Academy) as well as the representative organization towards foreign countries, e. g. in connection with the Pacific Science Congresses.

### 42. NETHERLANDS INDIES PACIFIC RESEARCH COMMITTEE (Buitenzorg).
### (NEDERLANDSCH-INDISCHE I.C.O-COMMISSIE).

**History and Scope.** With regard to the First Pan-Pacific Science Conference (Hawaii, 1920) and the then future Second Pan-Pacific Science Congress (Australia, 1923), the Science Section of the Royal Academy of Sciences at Amsterdam established the Netherlands I.C.O-Committee (I.C.O means Internationaal Circumpacifisch Onderzoek = International Circumpacific Research) in 1921, answering the initiative of the U. S. of America to internationalize scientific researches in the Pacific. This Committee contained members in the Netherlands as well as in the

Netherlands Indies. About the time of preparation of the Third Pan-Pacific Science Congress (Japan, 1926), the necessity was felt to have a central committee settled in the Netherlands Indies, acting as the representative organization towards foreign countries (cf. Art. 3, Constitution, Pacific Science Association). In 1925 about 10 colonial leaders of different scientific sections of the Netherlands I.C.O-Committee and representatives of scientific societies were appointed to form such a committee. Its first chairman was Dr. A. A. L. RUTGERS, who was also elected as leader of the Netherlands Indies delegation to the Japan Congress in 1926 and as General President of the Fourth Pacific Science Congress. Gradually the committee, now acting autonomously, extended itself. At present it contains 53 members. In January 1927 it started the first preparations for the Fourth Pacific Science Congress (Java, 1929) by appointing an Executive Committee, acting under the supervision of the Committee, which is at the same time, its advisor in detailed scientific matters. After the Netherlands Indies Science Council (No. 41) had been established and the representation of this colony towards foreign countries has been overtaken by that organization, the Committee will provisorely act as an advising body towards the Neth. Ind. Science Council (No. 41) as to minor questions. In January 1928 Dr. RUTGERS retired; as General President of the F. P. S. C. he was replaced by Dr. O. DE VRIES.

**Present state.** President: Prof. Dr. W. DOCTERS VAN LEEUWEN; Secretary: Dr. H. J. LAM (Buitenzorg) — The Committee is divided into 11 sections, viz.: I. Anthropology (leader Dr. H. J. T. BYLMER; 4 members); II. Botany (leader Prof. Dr. W. DOCTERS VAN LEEUWEN; 4 members); III. Chemistry (leader Dr. O. DE VRIES; 2 members); IV. Ethnology (leader Prof. Dr. B. J. O. SCHRIEKE; 6 members); V. Medical Sciences (leader .....; 4 members); VI. Geography (leader .....; 5 members); VII. Geology (leader Ir. A. C. DE JONGH; 5 members); VIII. Geophysics (leader Prof. Dr. J. BOEREMA, 4 members); IX. Agricultural Sciences (leader Dr. J. J. B. DEUSS; 12 members;) X. Volcanology (leader Dr. CH. E. STEHN; 2 members); XI. Zoology (leader Prof. Dr. H. C. DELSMAN; 1 member).

## 43. NETHERLANDS INDIES COMMITTEE FOR SCIENTIFIC RESEARCHES (Batavia—Weltevreden). (INDISCH COMITE VOOR WETENSCHAPPELIJKE ONDERZOEKINGEN).

Founded 1888.

**Present state.** Committee: A. M. HENS, Member of the Netherlands Indies Supreme Council, chairman; C. C. F. M. LEROUX, secretary; Prof. Dr. J. BOEREMA, F. DE BOER, K. A. R. BOSSCHA, P. LAGAAY, Ir. A. C. DE JONGH, Col. H. J. K. SCHUITENVOERDER, S. H. LEEGSTRA, Prof. Dr. W. M. DOCTERS VAN LEEUWEN, N. VAN ZALINGE, Prof. Dr. B. J. O. SCHRIEKE, members.

**Scope.** The aim of this committee is to promote, to prepare and to direct scientific exploration and to support individual explorers or scientific explorations sent out by other organizations; to develop and intensify our knowledge about the Malay Archipelago, both country and people, for scientific interest as well as for economic evolution.

The committee goes its own ways or collaborates with the Netherlands Indies Government and other corporations, especially Dutch societies with the same purposes.

The principal scientific expeditions prepared in recent years by the Committee are: *a.* the Central Dutch New-Guinea Expedition 1920—1922 — *b.* the Central-East-Borneo Expedition 1925 — *c.* the Dutch-American Expedition to Central New-Guinea 1926.

### 44. NETHERLANDS INDIES SCIENCE CONGRESS SOCIETY (Batavia). (VEREENIGING NEDERLANDSCH-INDISCH NATUURWETENSCHAPPELIJK CONGRES).

Founded June 22, 1918.

**Present state.** Patron: H. E. Jhr. Mr. A. C. D. de Graeff, Governor-General of the Netherlands Indies. Committee: Dr. D. de Visser Smits, general president; R. J. F. van Zeben, vice-president; Ir. M. G. van Overveldt, general secretary (Surabaja); Ir. R. Heida, joint general secretary; Dr. H. Müller, treasurer; W. M. Naessens, J. F. Hulk, commissioners — About 300 members.

**Scope.** Promotion of science in the Netherlands Indies by organizing congresses, usually covering 4 days, 1 day for excursions exclusive. Sections: *a.* Physics; *b.* Chemistry; *c.* Medicine; *d.* Veterinary Science; *e.* Botany and Zoology; *f.* Geography; *g.* Geology.

Congresses were held in September 1919 at Batavia (president Dr. W. van Bemmelen), May 1922 at Bandung (president Ir. W. Damme), September 1924 at Buitenzorg (president Dr. W. M. Docters van Leeuwen), September 1926 at Batavia (president A. de Waart) and September 1928 at Surabaja (president Dr. D. de Visser Smits).

**Publications.** Handelingen (Proceedings).

### 45. ROYAL SCIENCE SOCIETY IN THE NETHERLANDS INDIES (Batavia—Weltevreden). (KONINKLIJKE NATUURKUNDIGE VEREENIGING IN NEDERLANDSCH-INDIË).

Founded July 19th, 1850.

**Present state.** Patroness: H. M. the Queen — Committee: Prof. Dr. J. Boerema, president; Dr. J. I. J. M. Schmutzer, vice-president; Dr. S. W. Visser, secretary; Dr. W. F. Gisolf, treasursr; Ir. J. F. van Hoytema, director of buildings; Prof. Dr. H. C. Delsman, editor of the Journal — About 300 members.

**Scope.** Promotion of scientific knowledge in the widest sence by means of its publications, by its library and by organizing lectures. Local subdivisions have been founded in later years at Batavia, Bandung, Surabaja and Buitenzorg.

**Library,** containing some 20.000 books — Librarian: Mrs. M. Visser—Laban.

**Publications.** Natuurkundig Tijdschrift voor Nederlandsch-Indië (Netherlands Indies Journal of Science) (Ruygrock & Co., Batavia), I—LXXXVIII, 1850-hodie.

### 46. NETHERLANDS INDIES ASTRONOMICAL SOCIETY (Bandung) (cf. No. 4). (NEDERLANDSCH-INDISCHE STERRENKUNDIGE VEREENIGING).

Founded July 1, 1920.

**Present state.** Patron: H. E. Jhr. Mr. A. C. D. de Graeff, Governor-General of the Netherlands Indies — Board of Directors: ....., president; C. Donker van Heel, secretary-treasurer; Prof. Dr. J. Clay, Ir. Wouter Cool, Prof. Ir. J. H. G. Schepers, Mr. L. J. A. Trip, A. Ursone, members — Honorary president: Lt. General H. N. A. Swart; Honorary member: Vice-Admiral A. F. Gooszen — Board of Curators: ....., president; C. Donker van Heel, secretary; members, appointed by the Government: A. ten Broecke Hoekstra, Ch. J. I. M. Welter; appointed by the Society: L. C. M. van Eendenburg, R. A. Kerkhoven (vice-president), P. Lagaay, Col. H. J. K. Schuitenvoerder — About 100 members.

**Scope.** The society purposes the erection and maintenance of an astronomical observatory (see No. 4) in the Netherlands Indies and the encouragement of astronomical science.

### 47. ASSCCIATION OF CHEMICAL, TECHNICAL AND AGRICULTURAL ADVISERS TO THE JAVA SUGAR INDUSTRY (Surabaja). (VEREENIGING VAN CHEMISCHE, TECHNISCHE EN LANDBOUWKUNDIGE ADVISEURS BIJ DE JAVA-SUIKERINDUSTRIE).

Founded 1921.

**Present State.** Committee. President: Ir. A. SCHWEIZER, chemical adviser (in 1929: CH. G. M. PERK); Secretary: Ir. M. HOOLBOOM, technical adviser; treasurer: N. J. PEEREBOOM, agricultural adviser — Honorary member: Dr. T. VAN DER LINDEN — About 40 members.

**Scope.** The purpose of the association is to strengthen the bonds between the advisers to the sugar industry, especially with regard to their work, by means of annual meetings (held in February of each year), at which chemical, technical and agricultural matters are discussed, often in the presence of the Staff of the Sugar Experiment Station at Pasuruan (No. 32) and other guests.

**Publications**: Verslagen (Reports) van de Vereeniging van Chemische, Technische en Landbouwkundige Adviseurs bij de Java-Suikerindustrie, issued by the General Syndicate of Sugar Manufacturers in the Netherlands Indies, I—VIII, 1922-hodie.

### 48. NETHERLANDS INDIES PHARMACISTS ASSOCIATION (Batavia; seeretary at Bandung). (NEDERLANDSCH-INDISCHE APOTHEKERSVEREENIGING).

Founded November 7, 1923.

**Present state.** Honorary members: Prof. Dr. L. VAN ITALLIE, Leiden; Prof. P. VAN DER WIELEN, Amsterdam — Committee: J. M. M. BITTER, president; H. G. WINTER, vice-president; Dr. M. DUYSTER, secretary (Bandung); TH. H. M. HOGENBOOM, treasurer; Dr. H. WUITE, commissioner — corresponding member in the Netherlands: J. G. KOUFFELD, Bussum — About 90 members.

The Association is subdivided into 4 departments, viz. Batavia, Preanger Regencies, Central Java and Surabaja. It includes two special committees, viz. a Committee on Scientific Information and a Committee for Foodstuff-chemistry. It possesses a library at Bandung and issues a monthly periodical.

**Scope.** The Association aims, next to professional purposes, at the promotion of the study of scientific pharmacy and of a rational providing of the population with medicaments, by several methods and measures, among which: supporting or encouraging scientific investigations and issuing a monthly.

**Publications**: Pharmaceutisch Tijdschrift voor Nederlandsch-Indië (Netherlands Indies Journal of Pharmacy), I—VI, 1924-hodie.

### 49. ASSOCIATION OF OFFICERS OF THE TOPOGRAPHICAL SERVICE (Batavia—Weltevreden). (VEREENIGING VAN OFFICIEREN VAN DEN TOPOGRAFISCHEN DIENST).

Founded December 26, 1919.

In 1927 Prof. Ir. J. H. G. SCHEPERS reorganized the administration, especially with the purpose to gather funds for publishing the „Mededeelingen", which contain papers written by members of the Association and detailed discussions on essays,

published in other geodetical, geophysical and geographical periodicals. As it has not yet been incorporated, the Association remains semi-official.

**Publications**: Mededeelingen (Communications) van de Vereeniging van Officieren van den Topografischen Dienst, No. 1, Oct. 1927.

### 50. ASSOCIATION OF MINING ENGINEERS AND GEOLOGISTS OF THE MINING SERVICE.

### (VEREENIGING VAN INGENIEURS EN GEOLOGEN BIJ DEN DIENST VAN DEN MIJNBOUW) (Bandung).

Founded 1919.

**Present state.** Committee: Ir. W. A. J. AERNOUT, president; Ir. A. CH. D. BOTHÉ, secretary-treasurer; Dr. CH. E. STEHN, commissioner.

**Scope.** Next to professional purposes also the promotion of mining and geological sciences, e. g. by issuing a monthly periodical.

**Publications**: De Mijningenieur (The Mining Engineer), I—X, 1920-hodie. Editorial staff: Ir. A. C. DE JONGH, editor; Ir. V. REXHAUSER and Ir. J. REYZER, members.

### 51. ROYAL INSTITUTE OF ENGINEERS, NETHERLANDS INDIES BRANCH (Batavia; Committee at Sĕmarang).

### (KONINKLIJK INSTITUUT VAN INGENIEURS, GROEP NEDERLANDSCH-INDIË).

Established, both main and branch institute August 31st, 1847.

**Present state.** Committee: Ir. WOUTER COOL, president; Ir. F. C. VAN LIER, vice-president; Ir. C. F. M. DUYZINGS, secretary (Sĕmarang); Ir. F. B. H. ASSELBERGS, treasurer; Ir. L. HOUWINK, Capt. A. L. VAN DER SLUYS, Jhr. Ir. H. S. VAN LENNEP, members.

**Scope.** Promotion of technical sciences in the widest sense by organizing lectures, issuing publications, maintaining a library, supporting scientific investigations, etc.

**Publications**: De Ingenieur (The Engineer) (The Hague), I—XLVI, 1885-hodie.

### 52. ASSOCIATION OF CIVIL ENGINEERS IN THE NETHERLANDS INDIES (Batavia—Weltevreden).

### (VEREENIGING VAN WATERSTAATSINGENIEURS IN NEDERLANDSCH-INDIË).

Founded 1912.

**Present state.** Committee (1929; the Committee is replaced every year): Ir. W. LAMMERS, president; Ir. CH. F. VAN HAEFTEN, vice-president; Ir. W. F. EYSVOOGEL, secretary; Ir. J. TH. RIETVELD, Ir. J. O. DE KAT, members — Honorary secretary: ..... — Permanent representative in the Netherlands: Ir. P. J. OTT DE VRIES — About 160 members.

Subdivisions have been founded in 1916 at Batavia, Tegal, Sĕmarang, Surabaja, Djokjakarta and Bondowoso, in which towns the annual meetings are held in turn.

**Scope.** Next to professional purposes the Association aims at the promotion of engineering sciences, especially civil engineering. It endeavours to secure this object by organizing meetings and excursions, by entering into relation with other societies with similar aims, at home as well as abroad, and by issuing a monthly periodical.

**Publications**: „De Waterstaatsingenieur" (The Civil Engineer), 4°, Vol. I—XVII, 1913-hodie; containing important essays on technical and social problems connected with Public Works engineering (irrigation, waterpower, etc.). A comprehensive paper (in Dutch) on the Geological Survey of Java and Madura by Dr. G. J. N. HENGEVELD (Vol. VII, 1919), with geological map and illustrations may be mentioned separately. Editorial staff: Ir. J. H. VAN WITZENBURG, editor, seconded by two members of the Committee.

## 53. NETHERLANDS INDIES NATURAL HISTORY SOCIETY (Batavia). (NEDERLANDSCH-INDISCHE NATUURHISTORISCHE VEREENIGING).

Founded 1911.

**Present state.** Committee: Prof. Dr. H. C. DELSMAN, president-secretary; Dr. J. G. B. BEUMÉE, vice-president; Miss L. S. D. MERKUS, treasurer — About 750 members. Local subdivisions have been founded at Batavia, Buitenzorg, Bandung, Kediri, Surabaja, Malang, Djombang and Probolinggo.

**Scope.** Promotion of the interest in natural history by publishing a monthly illustrated periodical and by organizing lectures and excursions.

**Publications**: *a.* De Tropische Natuur (Tropical Nature) (VISSER & Co., Batavia), I—XVIII, 1911-hodie — *b.* Popular books on natural history.

## 54. NETHERLANDS INDIES SOCIETY FOR THE PRESERVATION OF NATURAL MONUMENTS (Batavia; Committee at Buitenzorg). (NEDERLANDSCH-INDISCHE VEREENIGING TOT NATUURBESCHERMING).

Founded 1913.

**Present state.** Patron: H. E. Jhr. Mr. A. C. D. DE GRAEFF, Governor-General of the Netherlands Indies — Committee: Dr. K. W. DAMMERMAN, president; T. OTTOLANDER, vice-president; .....; secretary; P. VAN ZON, joint-secretary; Dr. J. G. B. BEUMÉE, treasurer — About 500 members.

**Scope.** The society selects regions which require protection against cultivation, etc. for any reason and proposes the Netherlands Indies Government to take the measures necessary therefore. It has only one natural monument in own management, viz. a 6 hectares ground near Depok (Buitenzorg) with one of the very few rests of primaeval forest in the North Java plains. About 60 other natural monuments, scattered over the Malay Archipelago, but chiefly in Java, Sumatra and Celebes are now protected by the Government, some of them covering large areas of primaeval nature and extending from the sea coast to the summits of the highest mountain ranges (cf. sub publications, Communic. No. 8). In later years it has started also protection for certain animals, such as birds of paradise and also mammals. In many problems concerning the preservation of natural richness its influence on the Government has been considerable.

**Publications**: *a.* Mededeelingen (Communications), containing publications on selected natural monuments. A comprehensive conspectus may be found in Communication No. 8 (Overzicht der Nederlandsch-Indische Natuurmonumenten, by Dr. K. W. DAMMERMAN, Buitenzorg, 1924), with plates and maps. — *b.* Jaarverslag (Annual Report) — *c.* Illustrated postcards, etc. — Most publications are to be had at the treasurer's at Buitenzorg.

### 55. SOCIETY FOR THE PROMOTION OF MEDICAL SCIENCES IN THE NETHERLANDS INDIES (Batavia—Weltevreden). (VEREENIGING TOT BEVORDERING DER GENEESKUNDIGE WETENSCHAPPEN IN NEDERLANDSCH-INDIË).

Founded 1851.

**Present state.** Committee: Col. S. L. Brug, president; Prof. Dr. C. D. de Langen, vice-president; Dr. P. Peverelli, secretary; Dr. J. M. Elshout, treasurer; Dr. Ch. W. F. Winckel, editor of the Journal — About 750 members.

**Scope.** Promotion of medical sciences in the Netherlands Indies by issuing a bimonthly journal and by organizing lectures. Local subdivisions have been founded at Batavia, Sĕmarang, Surabaja, Malang, Medan (for Sumatras East Coast), Palembang (for South Sumatra).

**Publications**: Geneeskundig Tijdschrift voor Nederlandsch-Indië (Netherlands Indies Journal of Medicine) (G. Kolff & Co., Batavia), I—LXX, 1854-hodie (cf. No. 14).

### 56. SOCIETY FOR THE PROMOTION OF HYGIENICS IN THE NETHERLANDS INDIES (Bandung). (VEREENIGING TOT BEVORDERING DER HYGIËNE IN NEDERLANDSCH-INDIË).

Founded 1926.

**Present state.** Committee: Prof. H. M. Neeb, president; ....., vice-president; M. A. J. Kelling, secretary; Chr. van 't Hoogerhuys, treasurer; R. A. A. Achmad Djajadiningrat, R. A. A. Wiranatakoesoema, Col. S. L. Brug, Prof. Ir. H. van Breen, Ir. J. J. A. von Wolzogen Kühr, P. W. R. van Gesseler Verschuier, E. Hamakers, H. P. Chr. Hoetjer, Gen. H. C. Nauta, Dr. L. Otten, W. F. Zuur, members.

**Scope.** As expressed in the name of the society, which organizes exhibitions (1st Bandung 1927), etc.

**Publications**: the Society has published about 10 pamphlets, some of which are illustrated and in native languages.

### 57. NETHERLANDS INDIES SOCIETY FOR VETERINARY ARTS (Buitenzorg). (NEDERLANDSCH-INDISCHE VEREENIGING VOOR DIERGENEESKUNDE).

Founded 1884.

**Present state.** Committee: Dr. W. van den Akker, president; J. L. van Eck, vice-president; Dr. J. Witkamp, secretary; F. C. Kraneveld, treasurer — About 60 members.

**Scope.** Promotion of veterinary science in the Netherlands Indies by the edition of a journal and organizing lectures. The society is also professional.

**Publications**: Nederlandsch-Indische Bladen voor Diergeneeskunde (cf. No. 17) (Netherlands Indies Veterinary Journal) (Archipel Drukkerij, Buitenzorg, I—XLIV, 1885-hodie (Vol. I—XXXII, 1885—1917, entitled: Veeartsenijkundige Bladen voor Nederlandsch-Indië); occasionally also pamphlets.

### 58. ASSOCIATION OF GOVERNMENT AGRICULTURISTS IN THE NETHERLANDS INDIES (Buitenzorg). (VEREENIGING VAN LANDBOUWCONSULENTEN IN NEDERLANDSCH-INDIË).

Founded 1920.

**Present state.** Committee: M. B. Smits, president (acting); W. H. E. Schreuder, secretary; J. Th. Metzelaar, treasurer; about 60 members.

**Scope.** Next to professional purposes the Association aims also at the promotion of agricultural sciences, e. g. by issuing a monthly periodical.

**Publications**: „Landbouw" (Agriculture), I—IV, 1924-hodie.

### 59. ASSOCIATION OF FOREST OFFICERS IN THE NETHERLANDS INDIES (secr. at Semarang).
### (VEREENIGING VAN HOOGERE AMBTENAREN BIJ HET BOSCHWEZEN IN NEDERLANDSCH-INDIË).

Founded 1908.

**Present state.** Honorary members: A. E. J. Bruinsma, Bennekom (Netherlands); C. van den Bussche, Batavia—Weltevreden; Prof. Dr. H. A. J. M. Beekman, Wageningen (Netherlands); Dr. H. ten Oever, Salatiga; Dr. L. G. den Berger, Buitenzorg — Committee: Dr. Ir. F. Kramer, president; J. G. Westra, secretary; Dr. R. Wind Hzn., treasurer; A. C. Noltée, Ir. J. de Graaf, commissioners. — About 150 members.

**Scope.** Next to professional purposes the Association aims at the promotion of forestry science and its application on the Forestry Service in the Netherlands Indies. It endeavours to secure this object by organizing meetings for discussing forestry problems, by putting proposals and petitions concerning its purposes before the authorities, by publishing a monthly periodical, establishing and maintaining a reading-club and a library and by organizing excursions.

**Publications**: Boschbouwkundig Tijdschrift Tectona (Journal of Forestry Tectona), I—XII, 1908-hodie (cf. No. 19).

### 60. ASSOCIATION OF EXPERIMENT STATION PERSONNEL (Buitenzorg).
### (VEREENIGING VAN PROEFSTATION-PERSONEEL).

Founded 1919.

**Present state.** Committee: Prof. Dr. W. M. Docters van Leeuwen, president; ....., secretary; Dr. J. J. B. Deuss, treasurer; about 130 members.

**Scope.** This association contains the technical personnel of private experiment stations as well as that of the Department of Agriculture, Industry and Commerce. It aims at the promotion of the contact between those persons, occupied with investigations, directly or indirectly in the interest of the agriculture in the Netherlands Indies. In the annual meetings, which are hold in several centra of scientific life successively, a specially selected subject is discussed by several scientists.

**Publications.** The discussions, held at the annual meetings, are published as separate publications under the title: Verslag van de vergadering van de Vereeniging van Proefstation-personeel (Reports of the meeting of the Association of Experiment Station Personnel), 1920-hodie.

### 61. ROYAL BATAVIA SOCIETY OF ARTS AND LETTERS (Batavia—Weltevreden) (cf. No. 39).
### (KONINKLIJK BATAVIAASCH GENOOTSCHAP VAN KUNSTEN EN WETENSCAHPPEN).

Founded 1778 by Mr. Radermarcher.

This Society has to be considered as a semi-official institution, that relieves the Government for a great deal of its meddlings concerning Arts and Letters. In this connection the Society acts as a Government advisor.

**Present state.** Patron: H. E. Jhr. Mr. A. C. D. de Graeff, Governor-General of the Netherlands Indies — Committee: Prof. Mr. A. H. M. J. van Kan, president; Dr. G. W. Drewes, secretary; Dr. F. D. K. Bosch, treasurer; Mr. H. G. P. Duyfjes, P. Gediking, A. M. Hens, R. A. Prof. Dr. Hoesein Djajadiningrat, J. Hardeman, Dr. G. F. Pijper, Prof. Dr. B. J. O. Schrieke, Mr. L. J. A. Trip, Ir. E. H. M. Uljee, members.

**Sections:** 1. *Linguistics, Geography and Ethnology of the Netherlands Indies.* R. A. Prof. Dr. Hoesein Djajadiningrat, president; Prof. Dr. B. J. O. Schrieke, vice-president; Dr. P. Voorhoeve, secretary — 2. *Native Law.* ....., president; Prof. Dr. J. H. A. Logemann, vice-president; Prof. Mr. B. ter Haar, secretary-treasurer — 3. *Political Economics.* Mr. L. J. A. Trip, president; Prof. J. van Gelderen, vice-president; Dr. H. M. Hirschfeld, secretary-treasurer. — 4. *Law.* Mr. H. G. P. Duyfjes, president; Mr. E. J. F. van Dunné, Mr. Dr. M. A. G. Harthoorn, Prof. Dr. J. H. A. Logemann, Mr. J. K. Onnen, members.

**Library.** P. Gediking, librarian; Mas Patah, H. Winter, S. Chavannes, assistants.

**Linguistic Office for the cataloguing of Javanese manuscripts.** Raden Ngabehi Dr. Poerbatjaraka.

**Publications.** *a.* Tijdschrift voor Indische Taal-, Land- en Volkenkunde (vulgo: Tijdschrift van het Koninklijk Bataviaasch Genootschap van Kunsten en Wetenschappen) (Journal for Indian Philology, Geography and Ethnography, vulgo: Journal of the Royal Batavia Society of Arts and Letters) (Albrecht & Co., Batavia), I—LXVIII, 1852-hodie, containing papers on linguistics, ethnology, history and archaeology of the Netherlands Indies — *b.* Verhandelingen (Proceedings) van het Koninklijk Bataviaasch Genootschap van Kunsten en Wetenschappen (G. Kolff & Co., Batavia), I—LXIX, 1779-hodie, containing essays on different subjects concerning the scope of the Society. — *c.* Oudheidkundig Verslag (Report of the Archaeological Service), cf. No. 38.

### 62. MACASSAR SOCIETY OF ARTS AND LETTERS (Makassar). (MAKASSAARSCH GENOOTSCHAP VOOR KUNSTEN EN WETENSCHAPPEN).

President: Mr. H. A. Pet (acc. to Reg. Alm. 1928, II).

No communication has been received from the Committee of this Society. According to the „Encyclopaedie voor Nederlandsch-Indië" (A. 62), it possesses an important library.

### 63. NETHERLANDS INDIES BUREAU OF ANTHROPOLOGY (Batavia). (NEDERLANDSCH-INDISCH BUREAU VOOR ANTHROPOLOGIE).

Founded in 1925 as an autonomous division of the International Bureau for Anthropology, Paris.

**Present State.** Committee: Dr. P. V. van Stein Callenfels, president; Dr. H. J. T. Bylmer, secretary; Dr. J. M. Elshout, Prof. Dr. P. M. van Wulfften Palthe, Prof. Dr. W. A. Mysberg, Dr. J. W. Wolff, members.

**Scope.** The aim of this Bureau is to promote the study of anthropology in a wider sense, viz. of physical anthropology, ethnology, praehistorics, psychology and eugenetics; further to strengthen the bonds between those who are connected with those sciences. It purposes also to sustain the publication of communications concerning those subjects and intends to indicate a more definite direction and to further a closer cooperation regarding studies on the sciences mentioned.

# PERIODICAL SCIENCTIFIC PUBLICATIONS ISSUED IN OR USUALLY CONTAINING PAPERS CONCERNING THE NETHERLANDS INDIES.

*Note.*

No exclusively professional publications, nor, in general, mere annual reports are mentioned.

Many of the periodicals cited have been preceded by series of similar publications, differing a little as to title and scope. Such former publications have only been mentioned in a few cases.

The numbers within brackets indicate the number of the institution, society, etc. of the above conspectus by which they are issued or under which they have been mentioned. The residence of the publisher has only been added if not in the Netherlands Indies or if desirable for any other reason.

For the rest, cf. "Encyclopaedie voor Nederlandsch Indië", artt. Tijdschriften en Periodieken (IV, 459; A, 38), Vereenigingen (IV, 540; A, 360), and Botanische literatuur (I, 392).

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